412

TRANSACTIONS

OF THE

AMERICAN

SURGICAL ASSOCIATION.

VOLUME THE FOURTH.

EDITED BY

J. EWING MEARS, M.D.,
RECORDER OF THE ASSOCIATION.

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OFFICERS

OF THE

AMERICAN SURGICAL ASSOCIATION.

Elected at the Meeting, April 30, 1886.

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LIST OF THE PRESIDENTS

OF THE

ASSOCIATION FROM THE TIME OF ITS INSTITUTION.

ELECTED

1880. SAMUEL DAVID GROSS, M.D., LL.D., D.C.L. Oxon., LL.D. Cantab., LL.D. Edin.—Founder of the Association.

1883. EDWARD MOTT MOORE, M.D., LL.D.

1884. WILLIAM THOMPSON BRIGGS, M.D.

1885. MOSES GUNN, A.M., M.D., LL.D.

1886. HUNTER McGUIRE, M.D.

FELLOWS

OF THE

AMERICAN SURGICAL ASSOCIATION.

APRIL, 1886.

* Denotes Original Members.

ELECTED

1882. AGNEW, D. HAYES, M.D., LL.D., 1611 Chestnut Street, Philadelphia. Professor of Surgery and of Clinical Surgery in the University of Pennsylvania, Surgeon to the Pennsylvania Hospital, to the University Hospital, and Consulting Surgeon to the Orthopædic Hospital, Philadelphia.

*1880. ASHHURST, JOHN, Jr., M.D., 2000 West De Lancey Place, Philadelphia. Professor of Clinical Surgery in the University of Pennsylvania, Senior Surgeon to the Children's Hospital of Philadelphia.

1882. BARTON, JAMES M., A.M., M D., 1344 Spruce Street, Philadelphia. Surgeon to the Jefferson Medical College Hospital, and to the German Hospital, Philadelphia.

*1880. BENHAM, SILAS NELSON, A.M., M.D., 156 Third Avenue, Pittsburg, Pa.

1882. BILLINGS, JOHN SHAW, M.D., LL.D. Edin., Surgeon-General's Office, Washington. Surgeon U. S. Army. *Member of Council*, 1884–86.

1882. BONTECOU, REED BROCKWAY, M.D., 82 Fourth Street, Troy N.Y. Surgeon to Marshall Infirmary of Troy.

ELECTED

1882. Bozeman, Nathan, M.D., 307 Fifth Avenue, New York. Surgeon to the Woman's Hospital of the State of New York.

*1880. Bramble, D. D., M.D., 169 Broadway, Cincinnati, Ohio.

*1880. Briggs, William Thompson, M.D., corner Summer and Union Streets, Nashville, Tenn. Professor of Surgery in the Medical Department of the University of Nashville and Vanderbilt University, Surgeon to the University Hospital of Nashville. *President*, 1884.

*1880. Brinton, John H., M.D., 1423 Spruce Street, Philadelphia. Professor of the Practice of Surgery and of Clinical Surgery in the Jefferson Medical College of Philadelphia, Surgeon to St. Joseph's Hospital of Philadelphia. *Treasurer*, 1884–1885.

1882. Bull, William Tillinghast, M.D., 35 West Thirty-fifth Street, New York. Surgeon to the New York Hospital, to Chambers Street Hospital, Consulting Surgeon to St. Luke's Hospital and to the Hospital for Ruptured and Crippled, New York.

*1880. Byrd, William Andrew, M.D., 416 Jersey Street, Quincy, Ill. Professor of Clinical Surgery in the Quincy College of Medicine, Consulting Surgeon to the Sarah Denman Hospital, Quincy, Ill.

*1880. Cabell, James L., A.M., M.D., LL.D., University of Virginia, Virginia. Professor of Surgery in the University of Virginia.

*1880. Campbell, Henry Fraser, A.M., M.D., Augusta, Ga. Professor of Surgery and Gynecology in the Medical Department of the University of Georgia, Surgeon to the City Hospital and to the Freedman's Hospital of Augusta, Ga. *Member of Council*, 1882.

1885. Carmalt, William H., A.M., M.D., 87 Elm Street, New Haven, Connecticut. Professor of Surgery in Yale College, Surgeon to the New Haven Hospital.

ELECTED

1882. CHEEVER, DAVID WILLIAMS, M.D., 239 Boylston Street, Boston. Professor of Surgery, Harvard University, Surgeon to the Boston City Hospital.

*1880. COLEMAN, JOHN SCOTT, M.D., 563 Green Street, Augusta, Georgia.

1881. COLE, RICHARD BEVERLY, M.D., Ph.D., San Francisco, Cal.

1882. COMINGOR, JOHN A., M.D., 77½ South Illinois Street, Indianapolis, Ind. Professor of Surgery in the Indiana Medical College, Surgeon to the City Hospital of Indianapolis.

*1880. CONNER, PHINEAS SANBORN, M.D., LL.D., *Treasurer*, 159 West Ninth Street, Cincinnati, Ohio. Professor of Anatomy and of Clinical Surgery in the Medical College of Ohio, Professor of Surgery in the Medical Department of Dartmouth College, Hanover, N. H., Surgeon to the Cincinnati Hospital and to the Good Samaritan Hospital, Cincinnati. *Member of Council*, 1883.

1883. DANDRIDGE, NATHANIEL PENDLETON, M.D., 63 W. Eighth Street, Cincinnati, Ohio. Professor of Genito-Urinary Diseases in Miami Medical College, Surgeon to the Cincinnati Hospital and to the Episcopal Hospital for Children, Cincinnati.

*1880. DAVIS, SAMUEL T., M.D., 134 North Fourth Street, Lancaster, Pa.

*1880. DAWSON, WILLIAM WIRT, M.D., corner Third and Broadway, Cincinnati, Ohio. Professor of Surgery in the Medical College of Ohio, Surgeon to the Hospital of the Good Samaritan, Cincinnati. *Vice-President*, 1883.

1882. DENNIS, FREDERICK SHEPARD, M.D., 21 East Twenty-first Street, New York. Professor of the Principles and Practice of Surgery in the Bellevue Hospital Medical College, Surgeon to the Bellevue Hospital, to St. Vincent's Hospital, and Consulting Surgeon to the Hospital for Ruptured and Crippled, New York.

ELECTED

1882. DETMOLD, WILLIAM, M.D., 38 East Ninth Street, New York. Professor of Military and Clinical Surgery in the College of Physicians and Surgeons of Columbia College (Emeritus), Consulting Surgeon to the Presbyterian Hospital of New York.

1882. DUNOTT, THOMAS J., M.D., 132 Walnut Street, Harrisburg, Pa. Surgeon to the Harrisburg Hospital.

1883. FENGER, CHRISTIAN, M.D., 214 East Ohio Street, Chicago. Professor of General Pathology and Pathological Anatomy in the Chicago Medical College (Medical Department of Northwestern University).

1882. FORBES, WILLIAM SMITH, M.D., 1409 Locust Street, Philadelphia. Professor of Anatomy in the Jefferson Medical College of Philadelphia, Surgeon to the Protestant Episcopal Hospital of Philadelphia.

1882. GAY, GEORGE WASHINGTON, M.D., 589 Tremont Street, Boston. Surgeon to the Boston City Hospital. *Member of Council*, 1882.

*1880. GOULEY, JOHN W. S., M.D., *Vice-President*, 134 Madison Avenue, New York. Surgeon to Bellevue Hospital, New York. *Member of Council*, 1881.

1882. GREGORY, ELISHA H., M.D., LL.D., 1006 Olive Street, St. Louis. Professor of Surgery in the St. Louis Medical College, Surgeon to the St. Louis Hospital, St. Louis. *Vice-President*, 1884.

*1880. GROSS, SAMUEL W., A.M., M.D., 1112 Walnut Street, Philadelphia. Professor of the Principles of Surgery and of Clinical Surgery in the Jefferson Medical College of Philadelphia.

*1880. GUNN, MOSES, A.M., M.D., LL.D., 2101 Calumet Avenue, Chicago. Professor of Surgery in Rush Medical College, Surgeon to St. Joseph's Hospital, Chicago. *Member of Council*, 1880, 1886; *Vice-President*, 1882; *President*, 1885.

1882. HEWSON, ADDINELL, M.D., 301 South Fifteenth Street, Philadelphia.

ELECTED

*1880. Hutchison, Joseph Chrisman, M.D., LL.D., 130 Hicks Street, Brooklyn, N. Y. Surgeon to the Brooklyn City Hospital and to the Brooklyn Orthopædic Infirmary, Consulting Surgeon to the Kings County Hospital, to St. John's Hospital, and to St. Peter's Hospital, Brooklyn. *Member of Council*, 1880–81; *Vice-President*, 1884.

1882. Isham, Ralph N., A.M., M D., 321 Dearborn Avenue, Chicago. Professor of the Principles and Practice of Surgery in the Chicago Medical College (Medical Department of the Northwestern University).

*1880. Johnston, Christopher, M.D., Baltimore. Professor of Surgery in the University of Maryland (Emeritus). *Vice-President*, 1885.

*1880. Keen, William Williams, A.M., M.D., 1729 Chestnut Street, Philadelphia. Professor of the Principles and Practice of Surgery in the Woman's Medical College of Philadelphia, Surgeon to St. Mary's Hospital of Philadelphia.

*1880. Keller, James McDonald, M.D., Hot Springs, Arkansas.

*1880. Kinloch, Robert Alexander, M.D., 285 Meeting Street, Charleston. Professor of Surgery in the Medical College of the State of South Carolina, Surgeon to the Roper Hospital, to the City Hospital, and Surgeon and Gynecologist to St. Xavier's Infirmary, Charleston. *Member of Council*, 1880–81, 1886.

*1880. Levis, Richard J., A.M., M.D., Northwest corner Walnut and Sixteenth Streets, Philadelphia. Surgeon to the Pennsylvania Hospital and to the Jefferson College Hospital, Philadelphia.

*1880. Marks, Solon, M.D., 136 Wisconsin Street, Milwaukee, Wisconsin. Surgeon to St. Mary's Hospital of Milwaukee.

*1880. Mastin, Claudius Henry, M.D., LL.D., 110 St. Francis Street, Mobile, Ala. Surgeon to the Providence Infirmary, Mobile, Ala. *Vice-President*, 1883.

ELECTED

1883. McCann, James, M.D., 300 Penn Avenue, Pittsburg. Surgeon to the Western Pennsylvania Hospital, Pittsburg, Pennsylvania.

1882. McGraw, Theodore A., M.D., 107 West Fort Street, Detroit, Michigan. Professor of Surgery in the Detroit Medical College, Surgeon to St. Mary's Hospital and to the Harper Hospital, Detroit.

*1880. McGuire, Hunter, M.D., *President*, 513 Grace Street, Richmond, Va. *Member of Council*, 1880–85.

1882. Maclean, Donald, M.D., F.R.C.S. Edin., 72 Lafayette Avenue, Detroit, Michigan. Fellow of the Royal College of Physicians and Surgeons, Kingston, Ontario; Professor of Surgery and of Clinical Surgery in the University of Michigan; Surgeon to the University Hospital, Ann Arbor; Consulting Surgeon to the Harper Hospital, Detroit.

1882. McLean, LeRoy, M.D., 21 First Street, Troy, New York. Surgeon to the Troy Hospital in charge of the Sisters of Charity.

*1880. Mears, J. Ewing, A.M., M.D., 1429 Walnut Street, Philadelphia. Professor of Anatomy and of Clinical Surgery in the Pennsylvania College of Dental Surgery, Demonstrator of Surgery in the Jefferson Medical College of Philadelphia, Surgeon to St. Mary's Hospital, and Gynecologist to the Jefferson Medical College Hospital of Philadelphia. *Recorder*, 1881–86.

1885. Michael, Jacob Edwin, A.M., M.D., 246 Madison Avenue, Baltimore. Professor of Anatomy and Clinical Surgery in the University of Maryland, Surgeon to the University Hospital, Consulting Surgeon to the Presbyterian Eye, Ear, and Throat Charity Hospital, Baltimore.

*1880. Moore, Edward Mott, M.D., LL.D., 63 South Fitzhugh Street, Rochester, N. Y. Surgeon to St. Mary's Hospital of Rochester. *Vice-President*, 1882; *President*, 1884.

ELECTED

*1880. Morton, Thomas George, M.D., Philadelphia. Professor of Clinical and of Operative Surgery in the Philadelphia Polyclinic and College for Graduates, Surgeon to the Pennsylvania Hospital, to the Orthopædic Hospital, and to the Jewish Hospital, Philadelphia.

1886. Mudd, H. H., M.D., 500 N. Jefferson Avenue, St. Louis, Mo.

1882. Nancrede, Charles Beylard, M.D., 2109 Pine Street, Philadelphia. Professor of General and Orthopædic Surgery in the Philadelphia Polyclinic and College for Graduates, Surgeon to the Protestant Episcopal Hospital and to St. Christopher's Hospital for Children, Philadelphia.

1882. Norris, Basil, M.D., Surgeon U. S. Army, Vancouver Barracks, Department of the Columbia, Washington Territory.

1882. Owens, John E., M.D., 1806 Michigan Avenue, Chicago. Professor of Surgical Anatomy and Operative Surgery in the Chicago Medical College, Attending Surgeon to St. Luke's Hospital of Chicago.

*1880. Packard, John H., M.D., 1437 Spruce Street, Philadelphia. Surgeon to the Pennsylvania Hospital and to St. Joseph's Hospital, Philadelphia. *Treasurer*, 1880–83.

*1880. Pancoast, William Henry, M.D., 1500 Walnut Street, Philadelphia. Professor of Anatomy in the Medico-Chirurgical College of Philadelphia.

1885. Park, Roswell, A.M., M.D., 305 Delaware Street, Buffalo, New York. Professor of Surgery in the Medical Department of the University of Buffalo, Surgeon to the Buffalo General Hospital.

1882. Parkes, Charles T., M.D., 125 State Street, Chicago. Professor of Anatomy in Rush Medical College, Surgeon to the Presbyterian Hospital, Physician-in-Charge of St. Joseph's Hospital, Chicago.

ELECTED

1883. Peck, Washington F., A.M., M.D., 110 East Third Street, Davenport, Iowa. Professor of Surgery and of Clinical Surgery in the Medical Department of the State University of Iowa, Surgeon to the Mercy Hospital of Davenport, and Consulting Surgeon to the Mercy Hospital of Iowa City.

1881. Pollock, Alex. M., M.D., P. O. Box 838, Pittsburg, Pa. Surgeon to the Mercy Hospital and to the Passavant's Hospital of Pittsburg.

1882. Porter, William Gibbs, M.D., 1223 Spruce Street, Philadelphia. Surgeon to the Presbyterian Hospital and to the Philadelphia Hospital.

1882. Prewitt, Theodore F., M.D., *Vice-President*, 2126 Olive Street, St. Louis. Professor of the Principles and Practice of Surgery and of Clinical Surgery in the Missouri Medical College, Surgeon to St. John's Hospital, St. Louis.

1882. Prince, David, M.D., Jacksonville, Illinois.

1886. Ransohoff, Joseph, M.D., 296 Walnut Street, Cincinnati, Ohio.

1882. Reed, Thomas B., M.D., 1427 Walnut Street, Philadelphia. Surgeon to the Presbyterian Hospital, Philadelphia.

*1880. Richardson, Tobias G., M.D., 282 Prytania Street, New Orleans. Professor of Surgery in the Medical Department of the University of Louisiana, Surgeon to the Charity Hospital, New Orleans.

1882. Roberts, John B., M.D., 1118 Arch Street, Philadelphia. Professor of Applied Anatomy and of Operative Surgery in the Philadelphia Polyclinic and College for Graduates in Medicine, Surgeon to St. Mary's Hospital of Philadelphia.

1882. Rushmore, John Dikeman, M.D., 129 Montague Street, Brooklyn, N. Y. Professor of Surgery in the Long Island College Hospital of Brooklyn, Surgeon to the Brooklyn Hospital, to St. Peter's Hospital, and to the Brooklyn Eye and Ear Hospital.

ELECTED

*1880. Russell, Thomas Pember, M.D., Oshkosh, Wisconsin.

1882. Sabine, Thomas Taunton, M.D., 8 East Twenty-fourth Street, New York. Professor of Anatomy in the College of Physicians and Surgeons, New York.

*1880. Sayre, Lewis Albert, M.D., 285 Fifth Avenue, New York. Professor of Orthopædic Surgery in the Bellevue Hospital Medical College, Consulting Surgeon to the Bellevue Hospital, to the Charity Hospital, to St. Elizabeth's Hospital, and to the Home for Incurables, New York.

1882. Senn, Nicholas, M.D., 523 Twelfth Street, Milwaukee, Wis. Surgeon to the Milwaukee Hospital.

1882. Smith, Alan Penniman, M.D., 45 Franklin Street, Baltimore, Md. Surgeon to St. Vincent's Hospital, to the Union Protestant Infirmary, to the Hebrew Hospital, to St. Agnes's Hospital, to the Maryland Eye, Ear, and Throat Hospital, and to the Hospital for Diseases of Women, Baltimore, Maryland.

1882. Smith, Stephen, A.M., M.D., 31 West Forty-second Street, New York. Professor of Clinical Surgery in the University Medical College of New York, Surgeon to Bellevue Hospital and to St. Vincent's Hospital, New York.

1882. Squire, T. H., M.D., 409 East Church Street, Elmira, N. Y.

1883. Taylor, William Edwin, M.D., "Occidental Hotel," San Francisco, Cal. Professor of the Principles and Practice of Surgery in the Medical Department of the University of California, and in the Dental Department of the same University, San Francisco.

1882. Thomson, William, M.D., 1502 Locust Street, Philadelphia. Honorary Professor of Ophthalmology in the Jefferson Medical College of Philadelphia, Ophthalmic Surgeon to the Jefferson Medical College Hospital, Philadelphia.

1885. Thompson, J. Ford, M.D., 1401 H Street, N. W., Washington, D. C., Professor of Surgery in the National Medical College, Surgeon to the Garfield Memorial Hospital and to the Children's Hospital.

ELECTED

1882. TIFFANY, LOUIS MCLANE, A.M. Cantab., M.D., 137 Park Avenue, Baltimore. Professor of Surgery in the University of Maryland, Surgeon to the University Hospital, Baltimore. *Member of Council*, 1885–86.

*1880. TREMAINE, WILLIAM S., M.D., Buffalo, N. Y. Major and Surgeon U. S. Army, Professor of Surgery in the Niagara University of Buffalo, N. Y., Surgeon to the Buffalo Hospital of Sisters of Charity, Buffalo, N. Y.

1882. VANDERVEER, ALBERT, A.M., M.D., Ph.D., 28 Eagle Street, Albany, N. Y. Professor of Surgery and Clinical Surgery in the Albany Medical College, Consulting Surgeon to St. Peter's Hospital, and Attending Surgeon to the Albany Hospital.

1885. VARICK, THEODORE R., M.D., 239 Washington Street, Jersey City, N. J. Surgeon to St. Francis's Hospital and to Jersey City Charity Hospital.

*1880. WALES, PHILIP SKINNER, M.D., Surgeon U. S. Navy, 813 Vermont Avenue, Washington, D. C.

1882. WARREN, JOHN COLLINS, M.D., 58 Beacon Street, Boston. Assistant Professor of Surgery in Harvard University, Surgeon to the Massachusetts General Hospital, Boston.

1882. WATSON, B. A., A.M., M.D., 124 York Street, Jersey City, N. J. Surgeon to the Jersey City Charity Hospital, to St. Francis's Hospital, and to Christ's Hospital.

*1880. WEIST, JACOB ROWLAND, A.M., M.D., 118 North Eighth Street, Richmond, Ind. Surgeon to St. Stephen's Hospital, Richmond, Ind. *Secretary*, 1880–85.

*1880. WESTMORELAND, W. F., M.D., 55 Marietta Street, Atlanta, Ga.

1882. WHITE, J. WILLIAM, M.D., Ph.D., 1810 S. Rittenhouse Square, Philadelphia. Demonstrator of Surgery, Lecturer on Operative and Minor Surgery, Lecturer on Genito-urinary and Venereal Diseases in the University of Pennsylvania, Surgeon to the Philadelphia Hospital, and Assistant Surgeon to the University Hospital, Philadelphia.

ELECTED

1882. Willard, DeForest, M.D., Ph.D., 1818 Chestnut Street, Philadelphia. Lecturer on Orthopædic Surgery in the University of Pennsylvania, Surgeon to the Presbyterian Hospital, and Consulting Surgeon to the Home for Cripples, Philadelphia.

*1880. Yandell, David W., M.D., Louisville, Ky. Professor of the Principles of Surgery and of Clinical Surgery in the Medical Department of the University of Louisville.

HONORARY FELLOWS.

1885. Annandale, Thomas, Regius Professor of Clinical Surgery in the University of Edinburgh.

1886. Bigelow, Henry J., M.D., 52 Beacon Street, Boston, Mass.

1885. Billroth, Theodor, M.D., Professor of Surgery in the University of Vienna.

1885. Czerny, Vincenz, M.D., Professor of Surgery in the University of Heidelberg.

1885. Erichsen, John Eric, LL.D., Emeritus Professor of Surgery in University College, London.

1885. Esmarch, Friedrich, M.D., Professor of Surgery in the University of Kiel.

1882. Horwitz, P. J., M.D., Medical Director U. S. Navy, Philadelphia.

1882. Hunt, William, M.D., Surgeon to the Pennsylvania Hospital, Philadelphia.

1886. Langenbeck, von, Prof. Dr. Bernhard, 54 Kappellen Strasse, Weisbaden, Germany.

ELECTED

1885. Lister, Sir Joseph, Bart., D.C.L., LL.D., Professor of Clinical Surgery in King's College, London.

1886. MacCormac, Sir William, Bart., 13 Harley Square, London, W., England.

1885. Nussbaum, Dr. V., Professor of Surgery in Munich.

1885. Paget, Sir James, Bart., D.C.L., LL.D., London.

1885. Verneuil, A., M.D., Professor of Clinical Surgery at the Faculty of Medicine of Paris.

1885. Volkmann, Richard, M.D., Professor of Surgery at the University of Halle.

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NOTICE.

THIS volume of TRANSACTIONS contains the papers read before the Association at the meeting held April 28, 29, 30, and May 1, 1886.

The Association assumes no responsibility for the statements and opinions published in this volume.

REPORT OF THE COMMITTEE ON NECROLOGY.

JOHN STAIGE DAVIS, A.M., M.D.

Dr. John Staige Davis was born October 1, 1824, in Albemarle County, Virginia, and died July 18, 1885, in the sixty-fourth year of his age, at the University of Virginia, with which institution he had been connected as teacher in the Medical Department for a period of forty years. At the early age of seventeen he received his degree of A.M., and one year later the Medical Degree from this institution. After his graduation he spent some time in perfecting his knowledge of practical medicine in the hospitals of Philadelphia. He began the practice of his profession in Jefferson County, Virginia, removing thence in 1845 to the University of Virginia, when he received the appointment of Demonstrator of Anatomy. In 1849 he was elected to the chairs of Anatomy and Materia Medica, the duties of which he performed with great zeal and ability to the day of his death. He was distinguished especially as a teacher of anatomy, his lectures being characterized by clearness of diction and a wealth of illustration. The system of instruction introduced by him in the Anatomical Department was, without question, the most perfect in existence in any medical institution of the country and gave a reputation to the school and to its students. He was a kind and affectionate friend and was much loved and respected by his classes. He was a member of the American Medical Association, the State Medical Society of Virginia, and in 1882 was elected a Fellow of the American Surgical Association.

FRANCIS DEANE CUNNINGHAM, M.D.

Dr. Francis Deane Cunningham was born July 28, 1836, in Goochland County, Virginia, and died in Richmond, Virginia, September 11, 1885, aged forty-nine years. He received the degree of M.D. from the Medical College of Virginia in 1857, and from the Medical Department of the University of New York in 1859. During the time of his attendance upon lectures in New York he was Resident Physician in the Brooklyn City Hospital. After his graduation in New York he visited London and Paris and pursued his studies in the hospitals and clinics of those cities. Most of the time was devoted to the study of diseases of the eye and ophthalmic surgery. On his return, in 1861, he engaged in practice in partnership with his father Dr. John A. Cunningham, in the city of Richmond, and enjoyed a large professional success, especially in the treatment of diseases of the eye. In 1867 he was elected Professor of Anatomy in the Medical College of Virginia, which position he held until 1880, when he was elected Professor Emeritus. He was an active member of the State Medical Society of Virginia, of which he was one of the founders, and in 1875 President, and contributed papers to its *Transactions* as well as to the medical journals of Richmond. In 1882 he was elected a Fellow of the American Surgical Association. Dr. Cunningham was a highly accomplished surgeon and occupied a prominent position as teacher and practitioner.

JOSEPH W. THOMPSON, M.D.

Dr. Joseph W. Thompson was born in Graves County, Kentucky, June 27, 1838, and died March 30, 1886, at Citronelle, Alabama, where he had gone for his health, in the forty-eighth year of his age. He began the study of medicine at eighteen years of age, attending courses of lectures at the Nashville Medical College and later graduated from the University of Pennsylvania. After graduation he established himself in practice in Ballard, Kentucky. At the breaking out of the War

of the Rebellion he entered the Confederate service as surgeon of a Kentucky regiment and served until the close of the conflict, his last service being that of surgeon in charge of a post-hospital. At the termination of the war he took up his residence in Paducah, Kentucky, and soon acquired a large practice, becoming well known in that part of the State as a successful surgeon. He was a member of the medical societies of his city and vicinity, of the State Medical Society, and of the American Medical Association. He was elected a Fellow of the American Surgical Association in 1882.

Dr. Thompson was an earnest student of his profession and zealous in his efforts to acquire knowledge. His connection, as surgeon, with the extensive railroad corporations of his region of the country afforded him a large experience in the treatment of injuries incidental to railroad employés. Those injuries and their results he made the subjects of contributions to the medical journals and to the Societies of which he was a member. He was much beloved by his patients and highly esteemed as a good citizen, taking great interest in all efforts made to promote the welfare of the community in which he lived.

J. E. M.

ADDRESS OF THE PRESIDENT.

THE UNION OF NERVES OF DIFFERENT FUNCTION CONSIDERED IN ITS PATHOLOGICAL AND SURGICAL RELATIONS.

By MOSES GUNN, M.D.,
PROFESSOR OF SURGERY IN THE RUSH MEDICAL COLLEGE OF CHICAGO.

Custom, if not organic law, requires the President to open the proceedings of the various annual medical conventions by an address of a more or less formal character. Custom, too, in all similar bodies, generally requires this officer to select the subject which he proposes to consider; and thus there has naturally resulted an indulgence in a wide range of thought, from matters of simple history to abstruse disquisition.

My immediate predecessor, in his address one year since, suggested that, in this Association, a *résumé* of the progress of surgery for the previous years, or some especial scientific subject, should, in the future, constitute the subject-matter of the President's Address. Although the Association did not formulate and enact this suggestion as an amendment to our By-Laws, I propose to comply with its spirit, and shall present a few thoughts on certain points in the physiology and surgery of motor, sensory, and moto-sensory or mixed nerves.

Previous to the investigations of Magendie and Bell, no clearly defined efforts had been made to differentiate the motor and sensory nerves. It is true that Walker had, some years previously, asserted this difference and had announced the fact of a difference between the roots of the spinal nerves, but had

erroneously attributed motor properties to the posterior roots. It remained for Magendie, followed and supported by Bell, to establish clearly the fact of the motor qualities of the anterior, and the sensory qualities of the posterior roots. With the establishment of this truth, expressed, as it was, in language which emphasized the different qualities in the nerve trunks, there was born, also, the idea that the difference was intrinsic, a property appertaining to the nerve tubules and fibrillæ themselves; in other words, that a motor nerve was possessed of motor qualities by virtue of its anatomical and physiological organization; and that for identical reasons a sensory nerve was endowed with sensory qualities. No anatomical or histological difference between the motor and sensory tubules and fibrillæ was discovered, nor, so far as I am aware, sought for; and, certainly, the subtlety of nerve force itself was not calculated to encourage an attempt at differentiation in that respect. Still, the idea has generally, I think universally, prevailed that the difference between motor and sensory nerves was intrinsic, and depended on a peculiarity of the nerve itself; certainly the language generally used by writers and speakers conveys this idea. Is this the fact, or is the difference to be found in extrinsic conditions, viz., the anatomical organization at either end of the nerve? Is there a real difference in the nerve itself, such as enables a motor nerve to transmit only an order from the brain, or an influence from some other nervous centre to a muscle, and a sensory nerve to transmit only an impression received at its periphery to the brain or some minor nervous centre? Is an afferent nerve a nerve of that quality, and is an efferent nerve possessed of its efferent qualities intrinsically, or, so to speak, accidentally? Or, is the nerve trunk simply a conductor of a form of force, the effect of which depends entirely upon the machinery at either end of the nerve?

Upon the facts in the case which these questions seek to evolve, depends the possibility of satisfactory results in the section and physiological reunion of divided compound nerves, and the grafting of one compound nerve upon another where there has been so great a loss of the trunk of a nerve as not to

permit the approximation of the distal to the proximal portion of that nerve. Success in achieving satisfactory results by such operations, or a uniform lack of success, must afford, likewise, a tolerably reliable answer to these interrogatories—much more reliable than experiments upon some of the inferior animals, especially dogs, cats, rabbits, etc.

As to the literature of this particular branch of the subject, I have not been enabled to make an investigation. I remember, however, that thirty years since, Prof. J. Adams Allen, in an article which he contributed to the *Medical Independent*, published in Detroit, relative to Prof. H. F. Campbell's announcement of the excito-secretor function of the nervous system, used the following language:

"The effect is motory if contractile fibre be present. The effect is secretory if secreting organs be supplied. The effect is sensation if sensitive neurine be reached."

In the same article he further says:

"Heat will melt iron, explode gunpowder, harden clay, and destroy or fix colors. Are these several results indicative of any diversity in the force of heat itself? Are they not, rather, indicative merely of variety in the bodies acted upon? So it is with the excitor force which commands the tiny fibrillæ and cells in the nervous arc. They receive and transmit but the *single impulse*—and in a *single* manner. *The effect produced, then, depends upon the structure and condition* of the organ reached. . . . We might with equal propriety speak of a modification in the essence of the galvanic current, when, at one time, by ingenious mechanism, it is caused to print a telegram, and at another to decompose a mineral, at another to kindle a Drummond light."

Professor Allen was writing on the general subject of nervous action including the sympathetic with the cerebro-spinal system, and the following paragraph, although written with reference to a wide consideration of nervous action, is not without significance in the more limited view in which I am indulging in reference to motor and sensory functions. He says:

"It is, perhaps, safe to assume as probable that parts supplied with cerebro-spinal nerves exhibit more definiteness in their reflex phenomena than those supplied mainly by fibres from the ganglionic chain. But it remains to be proved that there is any more real difference between these two classes of nerve fibres than exists between striated and non-striated muscular fibres."

It is only in logical harmony with the whole of the paper, of which this is a quotation, to understand the expression in the last sentence "than exists between" as meaning *than depends upon* "striated and non-striated muscular fibres."

These generalizations are fully supported by anatomical structure, there being no anatomical difference discernible to distinguish a motor from a sensory nerve, except that which is found in its origin and at its final distribution.

The questions which interest the practical surgeon are these: Is the difference between motor and sensory nerve tubules and fibrillæ intrinsic—*i. e.*, anatomical; or does the difference depend simply and alone upon the physiological machinery at the ends of the nerves? And, is there a difference in nerve force itself?

In answer to these questions, we may appeal to experiments upon inferior animals, and to the results of surgical operations on man. Experiments on inferior animals, though of value, require severe scrutiny, or they may mislead; the nervous system of some animals tolerating lesions which would be destructive of function in man.

Reference will be made in this paper only to experiments which seem to yield positive, rather than negative evidence; and as some of the positive evidence which I shall offer completely invalidates some, at least, of the experiments, I shall not, I hope, be deemed illogical or prejudiced.

Philipeau and Vulpian divided, in dogs, the pneumogastric and sublingual nerves and united the central end of the pneumogastric with the distal or peripheral end of the sublingual. They, also, divided the lingual branch of the fifth nerve and the sublingual, uniting the central end of the lingual branch of the fifth with the peripheral end of the sublingual, tearing out at the same time the central end of the sublingual. Subsequent ob-

servation of, and experiment on, these cases showed that irritation, both of the trophic and special sense nerve, aroused muscular action in the muscles to which the sublingual is distributed; and that pinching the sublingual elicited expressions of pain, thus showing that a conductor composed of a special sensory and a motor nerve, or of a trophic and a motor nerve, united end to end, transmitted nerve force in both directions, the effect being that which is normal in the organ reached, viz., motion in the muscle and perception of impression, or sensation, when the force reached and impressed the brain. Nerve force travelled in both directions over the *new routes* established by the united trophic and motor nerves, and also by special sense and motor nerves, the effect being determined by the machinery at either end of the route.

Doctor Rawa,[1] of Kiew, has made numerous experiments on rabbits, cats, dogs, pigs, and goats, uniting in some instances the central end of one compound nerve with the peripheral end of another compound nerve having a different destination; in other instances, the central end of a sensory with the peripheral end of a motor nerve, and *vice versâ*. In these experiments he has not united the nerve trunks by abutting them end to end, but he has lapped them, or turned them up on one another and bound them lightly together, instead of suturing them. The results of his experiments he sums up as follows:

"*a*. The central nerve apparatus is enabled to innervate organs which do not belong to it, as soon as those organs are artificially brought in nervous connection with it.

"*b*. The central nerve apparatus is the chief nourishing agency (Haupternährungsherde) for the peripheral end.

"*c*. For the reëstablishment of function in the peripheral end of a divided nerve, which has been united to the central end of any other nerve, time is required, which varies from six to sixteen months."

In regard to statement *b*, viz., that the central end is the chief nourishing agency for the peripheral end, there may be a question as to the entire correctness of the assertion. The distal

[1] Centralblatt für die medicinischen Wissenschaften, No. 34, 1883.

end of a divided and ununited nerve certainly atrophies; but it may be a question whether this change is primary or secondary. A muscle deprived of nervous supply will atrophy; but the atrophy is probably the direct consequence of disuse, and thus secondary, for a muscle with full nervous supply, if disused, undergoes the same change, and here the change is, unquestionably, the consequence of inaction. In the divided nerve the same conditions obtain, and it is probable that the atrophy is, as in the muscle, the consequence of disuse. Nutrition in a nerve is not, probably, greatly different from nutrition in other succulent tissue, and it is not philosophical to suppose that, as an atrophied nerve becomes restored, it is restored by proliferative outgrowth from the proximal, along the tubules of the atrophied distal portion. Such a method of restoration certainly does not obtain elsewhere in the higher animal organizations.

These experiments of Dr. Rawa were made during the three years preceding July, 1883.

In April, 1880, E. P. Davis, then an assistant in the physiological laboratory of Rush Medical College, made for me, at my suggestion, the following experimental operation, a report of which I here give in his own words:

"A black and tan dog, weighing about ten pounds, was anæsthetized, and under careful antiseptic precautions the following experiment was made. The axillary plexus was exposed at its lower half. The median nerve was then severed after its bifurcation,[1] and also the ulnar and radial. The outer head of the median nerve was united to the ulnar, proximal to distal extremity, by a single fine catgut suture. The ends were carefully brought into apposition without tension. The inner head of the median and the radial were then united in the same way. The limb was brought to the dog's side, a plaster-of-Paris bandage was put about the thorax, confining the limb; the immediate dressing of the wound was antiseptic. The animal was slung in a box for ten days. At the expiration of this time the plaster was removed, and the wound found healed by first intention. Complete paralysis of motion and sensation was present. In somewhat less than four weeks this

[1] The nerve being viewed from a distal position.

began to disappear, and when the animal was subsequently subjected to examination by Professors Gunn and Allen, a perfect condition of nervous impulses of motion and sensation was observed. Full muscular power and nutrition existed."

In this experimental operation it will be observed that all the main trunks of the axillary plexus were divided, and that in uniting the heads of the median with the radial and ulnar nerves, the whole nervous supply was left to come through the two heads of the median to the radial and ulnar, and that the distal portion of the median was left entirely without nervous supply; and yet when the radial and ulnar connections with the central heads of the median became established, there was no paralysis, even in the muscles or integument supplied by the median. The explanation of this fact is reached through another experiment to which I shall presently call attention. The paralysis was complete, both as to motion and sensation, for more than four weeks after the severing of the nerves; and when restoration of nervous currents through the central median heads and the peripheral radial and ulnar ends took place, all paralysis completely disappeared, even in the parts supplied by the median which had no *direct* communication with the brain; the dog accompanying Dr. Davis on one occasion on a walk of several miles, behaving as lively dogs are wont to do under such circumstances, and apparently without fatigue. It seems to me, that this experiment was a crucial one, and that, so far as dog physiology is concerned, its evidence is entirely conclusive.

During the summer and autumn of 1885, Dr. H. W. Sheldon, first interne of the Presbyterian Hospital of Chicago, made, at my request, a series of operations on dogs, which involved the removal of a section of the ulnar nerve and the grafting of the peripheral end upon the side of the intact median. These operations were generally successful and *apparently* indicated that, through the engrafted connection, the parts supplied by the ulnar received their innervation. But another experiment suggested and made by Dr. Sheldon himself, destroyed com-

pletely their value. He simply removed a section of an inch or more of the ulnar trunk, and as soon as the wound was healed and the animal was relieved of the confinement incident to the dressings, it was observed that motion and sensation in the parts supplied by the ulnar were in no wise impaired. In this experiment the parts normally supplied by the ulnar were left completely without *direct* nervous supply, as were also the parts normally supplied by the median in Dr. Davis's operation; and yet there was no paralysis in these parts, sensation and motion being perfect in all portions of the forearm and paw. Whence, then, the innervation? The investigations of Arloing and Tripier, cited by Markoe in the September number of the *Annals of Surgery*, show that in the dog, as well as in several other inferior animals, "there are certain tubules which pass from one nerve to another in a continuous or in a reverse direction, to be lost on the nerve to which they have attached themselves at a varying distance on the adopted trunk. . . . . The most abundant anastomosis, however, is found near the peripheral termination of the nerves, where all the terminal twigs unite to form the network of final distribution." Thus there is furnished an *indirect* and *retrograde* route for the conduction of nervous force; and thus is explained what was observed in the two experiments of Drs. Davis and Sheldon described above, where the areas deprived of *direct* innervation were fully supplied by and through a *recurrent* and *indirect* route. In the experiment made by Dr. Davis, the route between the brain and the paw and muscles of the forearm was through the inner and posterior cords of the axillary plexus, the outer cord serving only as a route between the brain and the areas supplied by the musculo-cutaneous nerve. Thus we see that —at least in the dog, where there is a free peripheral anastomosis—the exsection of a single nerve trunk is not attended by marked loss of sensation or motion.

Nerve suture in man has become a recognized operation, both as a primary and a secondary procedure; and its results, as well as experimental operations on inferior animals, may be

advantageously invoked for light upon Professor Allen's generalization, viz., that the difference in function of motor and sensory nerves depends entirely and solely upon the organization at either end of the nerve. Let us consider, for example, such a case of nerve suture. It is not probable that the adjustment is ever absolutely perfect, so that the so-called sensory tubules and fibrillæ in the distal portion are brought in contact with corresponding elements in the proximal portion, and that the motor filaments are brought into like harmonious conjunction. In reply to this proposition, it may be said that Nature, in the proliferative process of repair, possesses elective powers. While this may be quite true, it is not proven, nor will it be susceptible of proof until we can individualize the sensory and motor elements of a nerve. It may be remarked, too, that in the experiments of Rawa, where he laid the nerve trunks to be united, side by side, instead of end to end, this invoked elective power is subjected to a most trying test—a test that challenges our utmost faith in behalf of Nature's resources.

But if we concede this elective power in Nature's reparative efforts to unite the ends of severed compound nerves, how shall we dispose of the experiments of Rawa, who crossed and united the severed pneumogastric and sublingual nerves, and restored functions, respectively, to the parts supplied by each? Such results prove conclusively that the motor, sensory, and trophic powers of nerves depend, not on the nerve itself, nor on a difference of nerve force, but on the organism at the end of the nerve.

Confusion of muscular action may well be anticipated after crossing and uniting nerves supplying antagonistic sets of muscles, but, even here, time and continually repeated efforts may be relied upon to bring order out of confusion. Professor Stephani is reported, in the November number of the *Deutsche medizinal Zeitung*, to have succeeded four times in six experiments in uniting the distal end of the median with the proximal end of the musculo-spiral, and the distal end of the latter with the central end of the former. Following immediately on the operation were complete paralysis and atrophy; but gradually

in the course of six to eight months there was not only restoration of muscular power, but harmony of action was also realized to a sufficient extent to enable the animals to run, but perfect extending power of the paw was not realized. The summary of Stephani's experiments, as reported in the periodical above referred to, makes no allusion to the function of sensation in the skin areas supplied by the nerves operated on, but it is presumable that in this respect there was restored function.

Nerve suture as a practical surgical operation, I have already observed, seems to be fairly established, both as a primary and secondary procedure. A primary will probably yield earlier results than a secondary operation. The distal portion not having undergone atrophy, will not require the time to regain lost nutrition and suspended function, which will be necessary in the case of a nerve in which atrophy has already taken place.

The intergrafting of a section of a nerve of an inferior animal, to replace extensive loss of a nerve trunk, probably, will be of too uncertain success to constitute it a standard operation. But can the grafting of the distal end of a nerve, in such a case, upon the side of, or into the trunk of an adjacent nerve secure to it a supply of nerve force? Rawa's results in his experiments of uniting nerves by side contact, would indicate a possible affirmative answer. It was with the view of determining this point that I suggested the experiments made by Dr. Sheldon last summer and autumn. But we have seen that, unless we divide all the nerves as was the case in Dr. Davis's operation, these experiments in dogs are valueless, the free distal anastomosis affording a retrograde route for nervous force. We must look, then, for the solution of this question, to the comparatively rare opportunities afforded in the course of surgical practice, to institute experimental operations in man. Such opportunities may be encountered in cases of accidental injuries causing extensive loss of nerve structure, or where for the removal of a large neuroma, similar nerve sacrifice is required. In the fifth number of the *Gazette Hebdomadaire*, 1876, there is reported a case occurring in the service of M. Després,

at the Cochin hospital, in which there occurred such an extensive destruction of the median nerve as to preclude the possibility of approximating the ends. He, therefore, determined to ingraft the distal end of the median with the trunk of the ulnar. Separating the filaments of the ulnar trunk he interwove the separated or fringed filaments of the distal median, thus accomplishing what he terms, "*suture par rapprochment et par intrication.*"

Fifty-four days after the operation the patient left for Vincennes with partially restored functions in the parts supplied by the median nerve.[1] Such restoration, though only partial at so early a date, certainly gave promise of further improvement; and would warrant further operative procedure in the direction of nerve grafting.

I have already stated that one of the ends in view, in the graftings made for me by Dr. Sheldon, was to determine the value of grafting a divided nerve upon the trunk of an adjacent nerve. I was at that time uninformed of Després's operation, an account of which I have just epitomized; indeed, it was not until I had made the operation on a patient who required extensive exsection of the ulnar nerve, that my attention was called to this case. Consequently, at the time of the operation I was not aware that I had a precedent for it.

On the 1st of December, 1885, I had occasion to resect between three and four inches of the right ulnar nerve for the removal of a neuroma in a male patient, thirty-six years of age. Having anxiously awaited an opportunity to make such an experimental operation, I proceeded at once to graft the distal portion of the divided nerve upon the trunk of the median. Desiring to avoid an injury to the latter nerve, and encouraged

[1] Ce malade part pour Vincennes le 13 (Sept.). A ce moment, le contractions du grand palmaire sont assez efficaces pour relever le main; l'opposant du pouce a pris un peu d'énergie, mais le fléchisseur propre de ce doigt ne transmet aucun mouvement; les tendons des fléchisseurs superficiéls des doigts de la main agissent bein; seul les tendons des fléchisseurs profond, de l'index, et surtout du medius sont faible; la troisième phalange n'est que très incompletément fléchie, surtout celle de l'index. L'insensibilité persiste toujours au niveau des deux dernière phalanges de l'index et du medius.

by the success of Rawa in uniting and restoring function by side contact, I denuded the trunk of the median of its sheath, so that I was enabled to lay the broadly chamfered distal end of the ulnar upon the denuded side of the median, to which it was fastened by three fine catgut sutures. The operation, dressings, and treatment of the wound were successfully conducted in reference to asepsis of the wound. Healing was without suppuration, but was not absolutely complete till the eighteenth day. Immediately after the operation there was complete paralysis of motion and sensation in the parts supplied by the ulnar. On the eighteenth day a careful examination showed a slight return of sensation along the ulnar side of the ring finger. In flexing the hand upon the wrist, there seemed to be contraction in the flexor carpi ulnaris; but in the attempt to flex the fingers, there was no response in the terminal phalanges of the ring and little fingers.

March 3d, three months after operation: There is marked increase of sensation on the ulnar side of ring finger; no sensation in little finger. No increase in range of motive power; a little more vigor, perhaps, in the action of the flexor carpi ulnaris, as shown by evenness of the flexion, the hand not deviating to the radial side in such action. There is still inability to flex the terminal phalanx of the ring and little fingers.

April 8th, four months after operation: Patient now feels a very light touch on the ulnar side of the ring finger; no sensation to touch in the little finger, but there is a feeling of warmth in it; whereas heretofore it has felt, and has been, cold. There is increased muscular power; the patient can now adduct the hand with considerable vigor, but as yet has no power over the terminal phalanges.

The positive evidence which these two cases of nerve grafting furnish at so early dates not only warrants further effort in this direction, but also corroborates the other evidences of the correctness of the postulate, that the function of a given nerve depends entirely upon the machinery at its ends, and not upon any intrinsic quality.

Fellows: Favored by your kindness, manifested one year ago, it is my duty to preside over your deliberations in this seventh session of the American Surgical Association. We have come together to make and renew friendships, and to impart to one another and to the surgical world the results of our experience, investigation, and thought.

As to the new friendships which shall ensue, let us hope that they will equal the old; and in the renewal of the old, let the grip be firmer and the heart still warmer; while in the spark which shall fly from the clash of thought let there be only the fire which purifies the subject, enhances esteem, and cements friendship. So shall our discussions be honorable to ourselves and profitable to surgical science.

DIAGNOSTITIAL LAPAROTOMY.

BY CHRISTOPHER JOHNSTON, M.D.,
OF BALTIMORE, MARYLAND.

LAPAROTOMY, ancient as our race, aided by Anæsthesia, set free in Eve the incarnation of human maternity.

It often appears, also, in all heathen mythology, as in the Jovian operation, done upon the dead Semele, and through which Bacchus was born. It was likewise practised, as in the former case, under the nepenthe of Death, upon the body of Coronis, by repentant Apollo, and Æsculapius lived.

Whatever wonder attached to this marvellous occurrence, it is clear that men entertained the idea of laparotomy, and, emboldened by whatever tradition or record, became heroic and practical and made the abdominal section. Once done, the performance was repeated from age to age, and without other application, perhaps, unless we admit the perversion of the idea in the Japanese hari-kari.

It was, however, always practised upon the cadaver; and not that only, but the Lex Regia (circa A. D., 672 B. C.) of Numa Pompilius required it to be performed upon every woman who died in the twenty-seventh week of pregnancy, unless reliable signs declared the death of the fœtus also.[1]

Although in antiquity it was frequently done upon the dead, it was, upon the authority of Brockhaus,[2] first attempted on the living woman by the surgeon Trautmann, of Wittemburg, in the year 1600. But Ambrose Paré, in 1579,[3] declares his "astonish-

[1] Brockhaus, Conversat. Lexicon, art. Kaiser-Schmitt.
[2] Loc. cit. [3] Œuvres, 2d ed., 1579, à Paris, p. 885.

ment that there were persons willing to affirm that they had seen women whose belly had been incised for the extraction of their children, not once only but several times, although such a thing," he says, "in reason, is not at all impossible to believe." The abdominal section was, however, established and practised; but it was reserved for modern surgeons to widen the comprehensiveness of its grasp so as to make it reach threatening pathology as well as fettered physiology, being part of a continuous operation by opening the way and then perfecting diagnosis.

The rapid advance of abdominal surgery now demands the attentive consideration of modern surgeons, and calls for an expression of opinion with regard to the position of the line limiting interference in certain classes of cases.

Although gynecologists or surgeons have led the way in modern operative procedure, it cannot be denied that the early general surgeon did the operation known as the Cæsarean section, and inspired men of a later period with confidence as to resources and results. Nevertheless the specialists before named have at present almost monopolized ovariotomy and hysterectomy, and are daily lowering the death-rate after these operations. No inquisition is necessary in this department; but if the eye be cast over the pathological possibilities of the male and the female abdomen generally, that cavity will still be found to enclose many a difficult problem which the knowledge and zeal of surgeons are constantly striving to solve.

Whatever the growth or condition which claims treatment, as in the province of surgery, there would still remain the question as to how to reach the seats of pathological change. The bladder yields up its calculus or papilloma through an extra-peritoneal incision; nephrolithotomy is practical outside of the peritoneum; colotomy is performed upon the uncovered large intestine; but what shall be done when the peritoneum intervenes between the surgeon and his aim? The answer is simple, laparotomy—which makes diagnosis positive in cases of doubt, and is preliminary to another surgical operation which is proper to be done. It matters not whether the operation be original,

as indeed the most familiar are oftentimes in their application, or usual; the point to be determined is whether the abdominal incision and the operation following are not, in the conditions named, rather a duty than an election. If the surgeon have no right to refuse to give air to a fellow creature becoming asphyxiated from obstruction in the air-passages, has he the option of refraining from surgical interference when the primæ viæ are obstructed in their function? The answer to this query hangs, first, of course, upon diagnosis; then, sometimes upon the record of the past, and not unfrequently upon the wise boldness of the surgeon, who must dare if he would win. He must, himself, establish precedent, or else surgery would be at a standstill. He has, nevertheless, abundant guides: paracentesis, aspiration, the famous case of Alexis St. Martin, whole histories of open wounds of the abdomen, and the co-related open wound treatment of gunshot injuries of the knee-joint as practised by surgeon Moses, but latterly with antiseptic precautions, together with very many laparotomies, explorative and other, which go far toward settling some doubtful questions. And Listerism now takes its place in the estimation of the many alongside of Anæsthesia in rendering possible the formerly impossible, and in giving force to the aphorism of Chelius, "The probable is not always, the improbable occasionally true."

The propositions, then, are, first, that for abdominal surgical affections all possible operations ought to be attempted, after the establishment of a precise diagnosis; and, second, that when a just diagnosis cannot otherwise be reached, as in urgent cases of intestinal obstruction, it may, and it ought to be eked out by an exploratory incision. The line, therefore, is a circle, which is made to include the whole belly.

Before proceeding to details, I would call attention to the fact that the mortality of abdominal incision without complication is stated at a low figure. From this representation it might appear that diagnostitial laparotomy has claims upon the surgeon, and confers a benefit upon the patient far outweighing the risk it imposes upon him. It opens, or may open, the way out of a spontaneously fatal labyrinth. Of course, it is out of

our province to speculate upon the apathy of the dog's peritoneum, and the great susceptibility of the human peritoneum; but we may be allowed to revert to the fact that the human peritoneum to be incised is not always fresh, healthful, and susceptible. It may be quite the reverse of this, and may even seem to defy rather decided manipulation, as in old cystic cases in which ovariotomy is done; but, unfortunately, outside of this group there are few or no degenerated serous membranes to attack, and in a large proportion of instances the cases are acute, and the demand for relief pressing.

It would be unfair to compare or contrast dissimilar surgical operations which penetrate the abdominal wall, if, by so doing, disfavor should be created as to operations projected or done as called for by particular pathological states. All operations may once have stood on the same level, but the frequency of repetition of certain ones has developed methods and multiplied new means and resources which cut down the death-rate. These are, therefore, to be regarded as examples that invite imitation where the pathway is not so trodden.

We now propose to consider briefly the *effects* and *mortality* of incised wounds of the peritoneum; then exploratory surgical traumatism not accompanied with or followed by further operation; and finally point out the class of cases in which, according to our opinion, diagnostitial laparotomy ought to be done. And here we would distinctly enunciate the proposition that a great consecutive mortality in no wise determines the want of value of surgical operations, while in most cases recoveries are to be recorded as total gains. Instead, therefore, of referring to a certain mortality after operations, successes should be made known as saving of life. And, of course, the oftener the *operations d'audace* are done the more advantageously is the technique of these operations modified, or it is better understood.

One would naturally turn to the surgical history of the late war with some expectations as to the number and variety of penetrations of the abdominal cavity without visceral injury, for, as Dr. Curtis declares,[1]

[1] Medical and Surgical History of the War of the Rebellion, Surgical vol., part ii. page 31.

"Autopsies and experiments on the cadaver establish, beyond doubt, the possibility of deep penetration, or even of transfixion of the abdominal cavity without visceral lesion, the foreign body gliding between smooth and movable organs."

Nine instances of such penetrating bayonet wounds are given in the reports of the war, of which seven were attended with traumatic peritonitis and three died. Incised and penetrating wounds, with protrusion of the intestine, are spoken of as not uncommon, and as having been inflicted with knives and dirks; but their number is not given, neither is the fate of the recipients. And notice of these wounds is finally dismissed with the remark that "penetrations or perforations without visceral lesions are very rarely inflicted." But little can, therefore, be gleaned from this source that bears upon our subject; and still less from the contemplation of great lacerated wounds and those of two distinguished generals, among others, whose abdomens were torn open by a shell, and through the opening the liver, stomach, and intestines were plainly visible, and underwent the manipulation which seemed necessary without hindering recovery. We say nothing has been gained, because surgical wounds of the abdomen, for exploration, are always incised, and we would seek to establish the inherent mortality of such a measure in order to determine the life-saving percentage of the operation to which it leads.

Unfortunately for our purpose, but almost necessarily as a part of abdominal cases, the record with regard to diagnostitial laparotomy is brief indeed. When, as usually happens, the surgeon approaches his case with his convictions fortified by knowledge, the operation is almost a foregone conclusion, and laparotomy, transforming conjecture into fact, becomes really a part of it. Now, although we have not been able to gather many statistics upon this point, the best names in surgery are responsible for the comparative harmlessness, under special circumstances, of an exploratory incision. Nevertheless, while the results of explorations and operations are faithfully given to the profession, diagnoses made through laparotomy and not

leading to operation, are not so carefully presented. It follows, therefore, that although we may claim the existence of an inherent mortality attaching to diagnostitial incision and search, we may not be able to fix its index absolutely. Still, of the 94 cases reported by Lawson Tait,[1] as a part of his 1000 cases of abdominal section, but 2 died, making a fatal percentage of 2.1, and furnishing an approximation toward the truth.

Add to these the very valuable case, No. 2, of Prof. F. S. Dennis,[2] in which, after explorative laparotomy, a thorough examination of the abdominal cavity was made, lasting half an hour. The wound was closed with catgut for the peritoneum, and silk for the linea alba and for the skin; and the patient made a most satisfactory and complete recovery. It is, however, reasonable to admit that its exponent ought to be much smaller in cases of tumor, in which the peritoneal cavity may be approached almost at leisure, than in cases of intestinal obstruction which demand a prompt and certain diagnosis, and are urgent for relief. Chronic disease undoubtedly renders the peritoneum less impressionable or callous, whereas incisions in the face of peritonitis are not so alluring. But there is another factor in the matter, and that is the time, which largely determines the gravity of the step, so that Mr. Treves[3] may be said to utter the sentiment of the profession when he declares that

"laparotomy (the whole operation done) is, in itself, not a serious undertaking; its high mortality in the present class of cases (intestinal obstruction) depends, I venture to believe, upon the fact that the operation is usually undertaken too late. It is regarded as a last resource, whereas it should be the first, since it is the only resource."

And, again, under the caption of *acute intussusception* the same author observes that

"against laparotomy, in these cases, many objections have been urged. In the first place, it is pointed out that an acute attack may

[1] Medical Record, New York, January 3, 1885.
[2] Medical News, Philadelphia, February 27, 1886.
[3] F. Treves, Brit. Med. Journal, August 29, 1885.

become a chronic one. This is true, but its occurrence is very rare. By far the greater majority of the patients do not live long enough to enter upon the chronic stage. Moreover, chronic invagination is exceedingly fatal, and out of fifty-nine recorded cases, taken without any selection, I find that there are no fewer than fifty-one deaths."

And, continues the same author,

"even if the diagnosis be ill-founded, the laparotomy merely resolves itself into an explorative incision. Such incision adds but a fractional part to the sum total of the risk to life involved."

It is evident, from the foregoing, that Mr. Treves regards laparotomy or what it leads to in the cases designated, taken together, as "not a serious undertaking;" and he is quite emphatic that when reduced to an *exploratory incision* it adds very little to the enormous risk which the patients he specifies are incurring. Besides all this, it must be borne in mind that the abdominal incision, intentionally diagnostitial, is fraught with so little comparative ill-consequence that its high value or necessity may fairly be claimed as an established and proper aid to diagnosis. The present state of surgical science, therefore, justifies laparotomy as a means of diagnosis, and does not rate its dangers high either when employed diagnostitially, or as a preliminary to other important operations. The fourth conclusion of Dr. Dennis[1] is absolutely to this point. It is:

"That laparotomy offers no great additional danger to the patient, if properly performed under the strictest antiseptic conditions."

Of all abdominal operations which are inevitably associated with laparotomy, those involving the uterus and its appendages, including the uterus ruptured in labor, fill, no doubt, the largest page; and if statistics are to be relied upon, those concerning the alimentary tract come next in order. Not that reliance is withheld from returns made by earnest and truthful surgeons, but it is feared that all the operations, in cases of intestinal

[1] Medical News, Philadelphia, March 6, 1886.

obstruction, are not placed permanently on record. Indeed, if Mr. Treves's conjectures be correct that

"statistics are quite useless as a means of ascertaining the real mortality after this operation (laparotomy); that probably the recorded cases bear to those that are unpublished, the proportion of one to ten, and it may be surmised that the great bulk of these unpublished cases ended in death."[1]

It is difficult, if not impossible, to ascertain the relative frequency of the two groups referred to, and, by the same ruling, doubt might also be thrown upon the statistics of gynecology. But we have more faith in statistics, as given, especially when the work of master hands in various operations in rating the recoveries higher and higher toward 100 per cent.

After the foregoing may be ranged all those operations upon the diseased pancreas in which Prof. Senn has acquired such authority, and upon neoplasms in other organs—in the kidneys, or omentum, or mesentery, or in a degenerate spleen.

With such a vast array of precedents now before us, it is difficult to hesitate as to the course to be pursued under circumstances which demand prompt and active interference, but which, a few years since, fettered the surgeon's judgment and stayed his hand. And, indeed, it is only through the window that laparotomy makes, disregarding the antiquated apprehension of wounding the peritoneum, that the good and true surgeons of our day boldly seize upon and crush out the causes of death which once lurked secure behind the abdominal wall. Thus, Mr. Lawson Tait is reported[2] to have said, in a case of obscure abdominal tumor "cut the patient open and find out." And your orator records the following reply to a question addressed to the late eminent surgeon, Dr. J. Marion Sims, at Newport, R. I., in 1872, before a patient, on whom he was about to do ovariotomy: "I never know exactly what I am to find

[1] F. Treves, F R.C.S., Intestinal Obstruction, etc., Philadelphia. Henry C. Lea's Son & Co., 1884.

[2] Journal of the American Medical Association, editorial. January 23, 1886.

until I get into the abdominal cavity." And I doubt not that the wisdom of these remarks will be admitted when the great hazard of the patients, who may die of an imperfect or incomplete diagnosis, or the peril depending on their pathological state, is borne in mind.

When we compare the Cæsarean operation of former days and its great mortality with the most recent Porro-Müller operations, and their percentage of saving of life of mothers and children as well, we are struck with the fact that while the dimensions of the modern operation, as to shock and other particulars, are largely increased, the fatality remains about the same for reported cases. Of course, we know that the classic operation was and is frequently done in private houses by different surgeons and in scattered localities, and that the results must show "the terrible influence of want of experience,"[1] while the Porro and the Porro-Müller operations are commonly done in opposite and convenient apartments adapted to surgical use, and with all the resources of modern art and of the best men; and we feel that the modern operation can lay no claim to performance upon the ground that, as censors of morals, surgeons ought to prevent a repetition of the occasion for it. But that is not the point—it is this: that the abdominal incision was as innocent when done in the old way, as it is now when followed by the very grave operation of extirpation of the uterus and annexes. And it follows, if we look over the whole field, that if the more formidable Porro-Müller operation do not swell the mortality, both as to mothers and children, the result is due to the employment of anæsthesia, to the modern surgeon's boldness by knowledge and faith, and probably to antiseptic surgery. That it is prophylactic need not come within the scope of our consideration; but we have yet to see what the old section may become if the same safeguards be thrown around it.

If the laparotomy, as now practised, and forming an integral of, or prelude to, a graver operation, enjoys its proportion of the advantages secured to other parts of the same operation, and is constantly repeated with diminished hazard, it ensues,

[1] Lawson Tait, Medical Record, New York, January 3, 1885.

as a matter of course, that explorative laparotomy, itself an operation of comparatively small danger, may also be performed with constantly decreasing jeopardy to the patient.

Hitherto we have treated explorative laparotomy as a thing proper to be done under certain circumstances, as a procedure justifiable in the eyes of the profession. We now take the higher ground, that the performance of the incision referred to—as, indeed, we have already intimated—becomes a bounden duty in a great variety of instances which, though presenting differences in their apparent urgency, call as imperatively for the application of a common principle. Of course, all the steps of the exploration are to be judged together, although the word laparotomy alone is employed; but it is a leading feature and is used comprehensively, and if there were no laparotomy there would be no digital or visual examination of the abdominal viscera.

There is one thing, however, which must be said of fenestral exploration, besides that the whole measure gains in facility and loses in danger by frequent repetitions, and it is this: that all the conditions of a perfect diagnosis are secured, and the record of a long array of perfect diagnoses makes the surgeon's knowledge positive, and tends so to improve his aptness and precision that, in many cases, explorative laparotomy may eventually be actually dispensed with. In other words, the light shed upon certain pathological states will bring about a reduction in the number of obscure cases and doubtful diagnoses.

It is now becoming to ask, When is explorative laparotomy called for? and this we proceed, without delay, to answer. But it must not be forgotten that every laparotomy is, to a certain extent, diagnostitial, and it has happened before now that while the initial abdominal incision has added nothing to an opinion previously entertained, it has opened the way to the impracticable, and quickly demanded the median suture.

In the first place, it might appear that ovarian cysts have characters which distinguish them absolutely; for all that, many tumors have been confounded with them, such as tumors of the mesentery, cyst of the pancreas, cyst of the kidney, uterine fibro-

cysts, and other pathological states. On the other hand, Keith, of Edinburgh, had established his diagnosis so surely as to be able on the 22d of January, 1872, to declare[1] that after he had performed 136 ovariotomies he had not committed a single error in diagnosis. But Senn,[2] of Milwaukee, assures us that

"in case the tumor (he speaks of) has assumed such dimensions as to fill the entire abdominal cavity, it would be impossible to differentiate between a cyst of the pancreas and of the ovary, even by a most scrutinizing examination. In very obscure cases, however, the author regards an exploratory incision, under antiseptic precautions, for diagnostic purposes, a justifiable procedure.

And the same may be said with regard to many other conditions of disease. In view of what has been advanced, it would seem unnecessary to establish groups of cases demanding or permitting explorative laparotomy; and it strikes us that one great class ought to comprehend the whole, so far as diagnosis is concerned, and that one other category might be accepted which would concern the direction of operative endeavor. In the *first group* we would associate all sorts of cases in which a diagnosis cannot be made out without laparotomy; and in the *second*, range all the cases in which, a diagnosis having been made, a definite line of operation could not be marked out in the absence of laparotomy, neither could a positive abandonment of active measures be entertained. Under every circumstance, however, a precise diagnosis is the thing to be determined; and as in the rest of the domain of surgery diagnosis rules all subsequent action, so, whether the surgeon needs guidance either as to the nature of an obscure pathological state or the course to be pursued after the abdomen has given up its secret, the whole question resolves itself into this, that inasmuch as laparotomy holds the key in all cases of doubt, both as to what is

[1] Correspondence—Ovarian Tumors. E. Randolph Peaslee, M.D., LL.D., New York, 1872, p. 123.

[2] Journal of American Medical Association, September 26, 1885, p. 342. The Surgical Treatment of Cysts of the Pancreas.

the matter and what is to be done or left undone, laparotomy should be called on to surrender that key. It must be, of course, that early operations in intestinal cases are those which save life the oftenest, and late operations are those in which death claims the majority; but such success has attended the efforts of bold surgeons who dared to unveil localized peritonitis, and in desperate cases to attempt to carry healing with the knife, that the question of time may have to be conditional. The earlier the operation the better, if the surgeon has his choice; but abandonment ought not to follow necessarily because the surgeon's aid has not been invoked until after unreasonable delay. And let us believe and trust that, even in cases where hope deferred has sickened the heart, precision of diagnosis may make amends, and, aided by the growing resources of the present time, including the benefaction of thoroughly skilled assistance, may swell the statistics of recovery toward the century of fruition.

SUMMARY.

Laparotomy, ancient as our race, aided by anæsthesia, set free in Eve the incarnation of human maternity.

It often appears, also, in heathen mythology, but as performed upon the dead. Men, therefore, entertained the idea, and then put it in practice.

The rapid advance of abdominal surgery calls for an expression of opinion with regard to explorative laparotomy.

The mortality of incised wounds of the abdomen, without visceral lesion, is low; so also is the surgeon's diagnostitial laparotomy. The feeble mortality of this operation is not to be measured alongside of that of the let-alone method.

Statistics in this connection are important, but it is feared that they are very incomplete.

It is assumed that, while in the old Kaiser-Schnitt and in the Porro-Müller operation, the abdominal incision is the same, and the shock and extent of the latter are greater, the fatality in reported causes of both is about the same. The abdominal section itself, therefore, shares in the benefit afforded by modern resources.

Apart from the fact that many, if not most, laparotomies are confirmatory or diagnostitial, we would establish two great groups of cases calling for laparotomy :

1st. All sorts of cases in which the diagnosis cannot be made without its aid. 2d. All those cases in which, a diagnosis having been made, no definite line of operation can be marked out, and no abandonment of active measures be entertained or justified.

Finally, under every circumstance, the diagnosis ought to be determined.

DISCUSSION.

Dr. A. VANDERVEER, of Albany, New York.

I must say that I feel a certain degree of embarrassment in being called upon to open the discussion on this paper.

Dr. Johnston has gone over the subject so thoroughly, so far as the discussion of the points which he has presented is concerned, that it seems almost like repetition to say anything more. At the same time, a personal contribution in the form of the experience which one gets from meeting with these cases, may not be far out of place.

There can be no doubt that the experience of all of us shows that in simple incised wounds of the abdomen, with no injury to the abdominal organs, the patients usually recover, even if left almost to themselves. In laparotomy, done in a careful way, the mortality is very slight indeed. With the experience that we have in the treatment of wounds with antiseptics, etc., we can safely go further. We often see cases of simple incised wounds of the abdomen, under the most unfavorable circumstances, recover. I recall the case of a man in the penitentiary who attempted to commit suicide by cutting his brachial artery. Failing in this, he made an opening in his abdomen, six inches long, through which protruded a large portion of the intestines. The intestines rolled out into the dirty blankets. The wound was supposed to be fatal, and no great care was practised in washing

the intestines. They were returned and an ordinary interrupted suture put in. The man made a good recovery. Here was a case in which there was no injury to the contents of the abdomen—simply an incised wound of the wall. The cases that give us anxiety are those which have been so well considered by Dr. Dennis, of New York, in which there is an injury to some coil of intestine, with the escape of the contents of the bowel and blood into the peritoneal cavity. These cases inevitably die unless relief is afforded. These are the cases which we should be able to reach more thoroughly in the future than we have been in the past. While now and then we meet with a case where the stomach is punctured and the patient recovers, yet this is the exception, and in these cases laparotomy, opening and enlarging the wound, should be employed.

As to gunshot wounds, occurring more particularly in civil practice, we know the results. The let-alone and opium treatment has been the one employed. It is a question whether under this method of treatment we have a well-authenticated case of recovery after a pistol wound with perforation of the intestine. The report of the Surgeon-General gives the histories of several cases of recovery after gunshot wounds during the late war, but in civil practice it is questionable whether there is a well-authenticated case of recovery after perforation of the intestine. When we think of this it seems to me that it is important to consider this subject of laparotomy and to teach the profession something in regard to it. There is wavering in the whole profession, and public opinion is decidedly against the operation. My own experience with gunshot wounds of the intestine, is that the friends of the patient will object to operation, and even if they are willing, the surgeon has the fear that the lawyers defending the prisoner will give the operation the credit of producing death, if that follows. We have much to do in overcoming the opposition in the profession, and more particularly that of the friends of the patient.

I would like to call attention to a case which occurred not long since in my own practice, and one which has given me a great deal of thought. The case was seen twice with the late Dr. William Hays. It is as follows:

Mr. A. was shot with a pistol, 28 calibre, on the morning of April 17, 1885. He was seen by the attending physician in the course of a few hours. I saw him twelve hours after the accident. The man was in good condition, not suffering much from shock. He weighed about two hundred pounds and was in his usual good health. At this time

he seemed to be reacting well, the expression was good, there was no coldness of the extremities. We discussed the necessity for laparotomy. From the emphysema about the opening I felt that perforation of the bowel had occurred, and that there was fecal extravasation. There were no symptoms of hemorrhage. When the operation was suggested the brother and sister of the patient objected very decidedly. As the man's surroundings were very bad, I did not urge it greatly. The physician was under the impression that the opium treatment might carry him through and no operation was done. This man lived a little over sixty hours. The autopsy was held twenty-seven hours after death. On the lower part of the abdomen two wounds were found, each one inch above the inner third of Poupart's ligament and about equidistant from the median line; a line of ecchymosis connected the two wounds, produced by the track of a ball passing through the adipose tissue. The most important wound was found six inches to the left of the umbilicus and five inches above the left anterior superior spinous process of the ilium. It was round, with ragged, dark colored edges, and exuded a purulent fluid. A crucial incision made through the wound showed the track of the bullet, one and five-eighths inches long, extending inward and downward and entering the peritoneum. The abdomen was then opened by an incision in the median line, with transverse incisions joining this at the line of the umbilicus. The abdominal walls were about an inch and a half thick, containing thick layers of fat. A large amount of offensive, brownish-black fluid escaped. The bowels were greatly distended. The wound of the peritoneum, one-quarter of an inch in diameter, was surrounded by extravasation and flakes of dark colored lymph. The peritoneum generally was dark from extravasated blood, and covered by layers and flakes of partly organized dark colored lymph. The bullet was found to have perforated the great omentum about one inch above the lower edge to the left of the median line. The bullet appeared next to have perforated both sides of a section of the small bowel, and to have passed between two other coils of small intestine, and to have been deflected so as to take a direction from left to right and almost horizontal, then to have passed downward and backward again, making one perforation, and another some distance further on at the junction of the mesentery with the bowel, and then to have entered the right psoas muscle. The bullet was found in the muscle resting on the brim of the pelvis, anterior to the right sacro-iliac synchondrosis. The bone was not roughened or splintered and the bullet only slightly

roughened and flattened. On removing the bowels and localizing the perforations, the first two were found opposite one another sixty-one inches below the pylorus. Nine inches below the last was the opening into the mesentery and bowel adjacent, and fifteen inches below the latter was a single opening into the bowel. It seemed as though the bullet entered the bowel by this last opening, passed through the cavity of the bowel, and emerged at the mesenteric opening before mentioned. The tissues posterior to the bowel wounds in the region of the right kidney, were deeply infiltrated and discolored with blood. At three or four points in the mesentery, collections of thick pus were seen. The other internal organs were healthy.

The question is whether or not in this case laparotomy—and the operation which Dr. Bull has done with so much credit—should have been performed.

August 10, 1875, a boy, aged ten years, shot himself just below the umbilicus with a pistol which he was handling, the ball, No. 22, passing directly backward. This patient remained in good condition for forty-eight hours, and lived for seventy-two hours. At the autopsy four perforations were found in the ilium alone. These four openings were eighteen inches apart, and could have been closed by an operation similar to that of Dr. Bull. These cases, occurring under my own observation, have given me considerable thought. They belong to that class which die if something is not done for their relief. I have had two cases of rupture of the intestine, cases which are now attracting some little attention. One was the case of P. J. F., aged four years, who was injured September 20th, by the wheel of a cart passing over the abdomen. There were no external marks of violence. He lived forty-eight hours and died with all the symptoms of perforation. At the autopsy, made thirty-six hours later, a pint and a half of fecal fluid was found in the abdominal cavity. The mesentery was much discolored. There was rupture of the upper portion of the jejunum. There was also rupture of a bloodvessel in the mesentery opposite the tenth or eleventh dorsal vertebra. There was no injury to other organs. Here is a case in which it is a question whether an operation would not have saved life. In another boy, ten years of age, who fell upon a stick, a similar injury was produced, the patient dying in four days with symptoms of perforation.

It seems to me that the great field and the great work which we have before us is in regard to the application of laparotomy in connection with intestinal obstruction. We are not infallible as surgeons.

We have the practice of two strong men in our profession of whom it may be said that they advocate absolutely different lines of treatment in intestinal obstruction. I have great respect for Jonathan Hutchinson, and know that his views are somewhat different from those held by others. He would anæsthetize the patient, knead the abdomen, put him in a blanket, turn him upside down, and so on. If that does not succeed, he would repeat the treatment a day or two later, and would not do laparotomy except as a last resort. Treves, on the other hand, is decidedly in favor of operation. I have seen a number of Treves's cases, and I have seen him have three or four in the hospital at one time. He was very earnest in doing the operation, and perhaps did it in some cases where a little more earnest effort in distending the bowel might have brought about recovery without operation. When we have failed in making a clear diagnosis and have failed in all methods of treatment of which we know to relieve the intestinal obstruction, why wait any longer? Why not do this operation, which is comparatively safe? We have had our attention called to it by Tait, Parkes, Dennis, Bryant, and Bull. Why should we hesitate? There is a great deal of hesitation on the part of surgeons as to the proper time for operating. Shall we wait until collapse comes on? I think not. It is then too late: but up to this time, according to my experience, we meet with opposition on the part of the family and friends. We should endeavor to do the operation in some case which will result in a cure. Public opinion needs some encouragement. The community must be educated to it. They must be made to understand that these cases can be saved. During the past twelve years, I have had a number of these cases, and in going over my note-book, I find opposite many of them that the operation was not performed on account of objection of the patient or friends. Sometimes it has been the physician who was not willing to have the operation performed.

I have notes of cases which have occurred within a short time. Here is one that is worthy of record:

J. P., aged forty-six, married, a farmer by occupation, has paid, for many years, much attention to the raising of tobacco. During the past winter he has worked in the house for curing the tobacco and inhaled a great deal of the odor. For the past eight years he has suffered from attacks of pain in and about the epigastrium, which have been attributed to indigestion, the passage of thickened bile, and to constipation. He had been treated in many ways, by many physicians. He always obtained relief by a good movement of the bowels followed

by a small anodyne. During the past winter the attacks of pain have grown more frequent and severe. For the past five or six years he has been gradually losing flesh, and feeling well only a portion of the time. His friends thought that his condition was largely due to his continuous hard work. Thursday, March 18, 1886, he was taken with his old pain, which yielded, however, to small doses of opium, and for thirty-six hours he was better. On Saturday he ate quite freely of corned-beef and boiled cabbage, and soon after was much worse, vomiting contents of the stomach, and suffering severe pain. His physician, Dr. Elwood, of Schenectady, was again called, and relief was afforded by small doses of opium and carminatives, in connection with an enema. This caused a slight movement of the bowels. Tuesday morning he vomited freely, and expressed himself as feeling badly. He located the pain below the xiphoid cartilage. The countenance was anxious. There was little tenderness on pressure, with no abdominal distention. He was given small doses of calomel and mild laxatives, but no free movement of the bowels followed. The pain was relieved by small doses of anodynes. He took some nourishment, but did not retain it well. Urine was passed freely. On Wednesday and during the night he was quite comfortable. On Thursday, after a large enema of soap and warm water, there was a large and free movement of the bowels; yet during that night, and on Friday and Saturday, he vomited freely and was much exhausted. The pain was not great, but the patient was decidedly restless.

I saw him with Dr. Elwood, Sunday, March 26th, at 3 P. M., and made a thorough examination. There was no distention of the abdomen, no particular zone of tenderness on pressure, no jaundice, urine normal in appearance. No impacted feces and no tumor could be found, after placing him in various positions for examination. There was no evidence of hernia. The patient thought that he had passed no gas from the bowels for thirty-six hours. With his physician, I believed it to be a case of partial obstruction of the bowel from slight invagination or grasping of some portion of the small intestine by old adhesions, or obscure internal hernia. Hands and feet were warm, surface of body warm, pulse 84, temperature 100°. He had not vomited for ten hours. Was thirsty, taking pieces of ice, also brandy and cold tea. Was quite restless and much emaciated. He had never vomited blood. I suggested the use of large enemas of tea from chamomile flowers and the administration of a tablet of morphine one-sixth of a grain, with atropine one-fiftieth of a grain, every four or six

hours as was needed to afford relief. Such nourishment as he could retain, was ordered. He was quite comfortable through Sunday night, Monday, and Monday night. Tuesday morning he began to vomit large quantities of fluid mixed with fecal matter. No movement of the bowels, nor escape of gas, had followed the injections. I saw him Wednesday, March 31st, at 12 M., and found him much exhausted, with anxious face, slight coolness of the extremities and of the surface of the body, very restless, pulse weak—100 per minute, temperature 102°. He retained only for a few hours, liquid taken into the stomach. There was no distention, no tenderness, and but little pain. Laparotomy was suggested, but the friends, as well as Dr. Ellwood and myself, considered the patient too feeble to bear it. He continued to sink and died April 1st, after an illness of about thirteen days.

The autopsy was made twenty-four hours after death and showed constriction of the jejunum about eighteen inches from the pyloric orifice of the stomach, in length only two inches, and through which only a small probe could be passed. The gut was about the size of the index finger, the walls being thick and very dense, and when cut into had the appearance of carcinoma. Above the constriction the intestine was very much dilated, a large pouch having formed, containing a substance which presented the appearance of having been well digested. No evidence of disease could be found elsewhere. Could not a laparotomy with a comparatively small excision of the intestine have been done here on the Sunday before his death? This might have saved his life.

I could report other cases. In one case a portion of the intestine slipped into an old rent in the mesentery and was treated as a case of painter's colic. I saw the case a few hours before death. It evidently was a case of obstruction. No operation was allowed, yet laparotomy might have saved life, as only one small knuckle of intestine was found in the rent.

Dr. Johnston's paper presents many points of great interest and impresses this upon us, that we should go on and perform diagnostitial laparotomy. We must do it in more cases in the future than in the past. We practise laparotomy in the diagnosis of many abdominal tumors. I have seen Tait place a patient on the table and say, "we will take out the uterine appendages," and yet have seen him fail to do so on account of adhesions. Finding such a condition, he has remarked, "this patient will be no worse for the operation. She will recover," and the patient did recover although he worked among the

intestines for some time and was unable to tell the difference between the Fallopian tube and intestine.

About two years ago, I operated on a colored woman with uterine fibroid, with the expectation of removing the uterine appendages. The adhesions were such, however, that I did not succeed. This woman was told that she had had a successful operation, and, strange to relate, from that time she has continued to improve and is a well woman to-day. In another case, I admit that an error of diagnosis was made. I expected to do an operation for the removal of an ovarian cyst. I made the incision and found the left Fallopian tube and broad ligament studded with papillomatous growth and no ovarian enlargement whatever. The abdominal cavity was filled with fluid and the peritoneum was covered with papillomatous growths. Tait has said that simple incision of the abdominal wall will often do these cases good. This operation was done ten months ago. The patient was told that it was successful. She recovered from the operation in six days. I saw her two weeks ago and she was the picture of health.

One word with regard to the manner of doing the operation. The median incision is undoubtedly the best. I have four cases of intestinal obstruction which I could report in which the autopsy was made with great care. In two of these it would have been impossible to have reached the seat of obstruction without letting out the gas. I have seen Tait do the operation for intestinal obstruction, by bringing into the incision the most prominent fold of intestine, laying it open, allowing its contents to escape, and then attaching the intestine to the peritoneal borders of the incision. By letting out the gas, one is able to complete the operation. One may do a lateral laparotomy or enlarge a gunshot wound, but this is always embarrassing. It is better to make the median incision. I have records of thirty-one abdominal sections. Most of these were cases of ovarian tumor, some of fibroid tumors, and some for the removal of the uterine appendages. I must say that I have not always gone directly through the linea alba. I have, however, never had a case in which I have regretted going through the muscular tissue. I close the wound in the way that Spencer Wells advocates so earnestly. Dr. Johnson has referred to the closing of the wound with that care which is spoken of by some surgeons—that is, to bring the peritoneum together with cutgut sutures, then the muscles with silk or catgut, and lastly the skin with silver. I do not believe that we gain anything by closing the wound in this way. I believe that

by the good old way of Spencer Wells—that is, by including all the tissues in the suture and bringing them together fairly—we shall get a successful result. I believe that one will rarely get stitch-hole abscesses if the operation is done thoroughly and antiseptically so far as clean hands and instruments are concerned. Mr. Tait has one assistant who assists him in all his operations. I said to him one day, "You must have a royal good chance for studying abdominal surgery." He replied that during two years he had only a few times had his hand in the peritoneal cavity." Mr. Tait allows no one except himself to put his hand into the peritoneal cavity.

His method of getting into the cavity is not much different from that in present use. I have seen my old friend, Dr. Peaslee, take from one-half to three-fourths of an hour to get through the abdominal wall. Now by lifting up one fold of the skin, muscles, and fascia at a time and controlling the hemorrhage by the small artery clamps, one gets into the cavity within from five to fifteen minutes, and thus relieves the patient of the shock of a long operation.

As to the dressing, we should use all care as to antisepsis. I like the simple dressing of Mr. Lawson Tait—that is, the Gamgee pad with adhesive plaster—and I have seen no unsatisfactory result from its use.

We can do this operation anywhere. It is, however, better to do it in a well-regulated hospital, where good nursing, perfect ventilation, and absolute rest can be secured. In gunshot wounds, this cannot always be obtained, and we must operate at the house of the patient. In such cases, the corrosive chloride solution and spray should be thoroughly used. We should do the operation sufficiently often to convince the public that it is a proper operation in cases of intestinal obstruction, which, if nothing is done, will end fatally.

Dr. J. Ewing Mears, of Philadelphia.

I understand the title of Dr. Johnston's paper to be "Diagnostitial Laparotomy." In the discussion of it I think that we should confine ourselves to the title of the paper. If we include in the discussion the subject of laparotomy with regard to the treatment of the various pathological conditions which occur within the abdominal cavity, and also with reference to the various conditions produced by traumatism, we open a field of discussion which I think does not belong to the paper which has been read.

I should arrange the subject in this way, so far as relates to diag-

nosis, in conditions occurring within the abdominal cavity requiring treatment. In the first place, external examination; then internal examination where this can be made, so far as relates to growths which may be reached through examination of the pelvic cavity; then aspiration; and, finally, laparotomy. I should place laparotomy as I do, in the last place, because I regard it as the most serious method of examination that can be made.

We have to discuss, it seems to me, simply the propositions which have been presented. We find that these propositions are: 1st. All sorts of cases in which the diagnosis cannot be made without its aid. 2d. All those cases in which a diagnosis having been made, no definite line of operation can be marked out, and no abandonment of active measures be entertained or justified. We have nothing to do with laparotomy as a means of treatment of the condition within the abdominal cavity. I am free to state that I do not hesitate to open the cavity when it is necessary. Still, the more my experience increases, the more does it lead me to believe that the abdominal cavity should not be opened without due consideration and without hesitation. Death is a very severe penalty to pay for the perfection of diagnosis, and that has been paid in many instances.

The study of the morbid conditions occurring in connection with the stomach which has been made by Loretta, of Italy, Billroth, of Germany, and by others, has enabled us, by external manipulation, to determine quite accurately these conditions—sufficiently so, at least, to justify us in the performance of operations upon it. With regard to the liver and especially with regard to the gall-bladder, very extensive investigations have been made. Last year we had an able paper by a Fellow of this Association, Dr. Parkes, which gives a great deal of information with reference to methods of diagnosis in conditions involving the gall-bladder. Dr. Senn, our distinguished Fellow, will give us, at this meeting, much information with regard to means of diagnosis in diseases of the pancreas. The surgeons of Germany and Italy have given us information in regard to the methods of distinguishing conditions of the spleen. Conditions of the intestinal canal, as acute and chronic intestinal obstruction, have been studied, not only by members of the profession in this country, but by those on the continent of Europe and in England; so that we have already learned a great deal in regard to methods of diagnosis by means of external examination, and it seems to me that with regard to the organs within the abdominal cavity, we should not too hastily resort to the method by laparotomy in

order that we may see with our eyes the condition which is present. We should rather cultivate in the ends of our fingers, that skill which will enable us, so far as possible, to make the diagnosis of the conditions which exist. I am inclined to think that at the present time the tendency is rather to open the abdominal cavity, than to cultivate that very essential skill which is necessary to determine the condition without resorting to abdominal section. I know that incited and somewhat governed by the very sanguine statements of Mr. Tait, some of the younger members of the profession are very apt to open the abdominal cavity without consideration, simply because he has stated that it is a matter of very little consequence.

It, therefore, occurs to me to suggest that in discussing this question of diagnostitial laparotomy, we should discuss it in relation to those methods which have been used, both by external and internal examination, before we resort to this operation. Mr. Tait states that it is only necessary to make a slight incision and to introduce one, or at most two fingers, and that in that way he is able to determine the conditions which exist. I have had some experience in abdominal surgery, and I have, in many instances, found that it has required more than the introduction of one or two fingers and a large incision to enable me to determine the conditions that exist. It must be borne in mind, moreover, that in many of the cases in which diagnostitial laparotomy would be called for, great abdominal distention is often present, which will complicate the operation.

I have at present a case in consultation in Philadelphia; that of a lady, sixty-eight years of age, suffering from an obscure abdominal tumor. I have made external examinations, and examinations by the vagina, and have determined that the condition is one of carcinoma. I have never yet felt that it was my duty to perfect the diagnosis by opening the abdominal cavity. I have carefully watched for signs indicating the occurrence of suppuration. I should then feel that it was my duty to open the abdominal cavity, not for diagnosis but for the purpose of giving relief by treatment.

I have had recently a case in which I was very strongly impressed by the results which followed the adoption of what may be termed the conservative method. The patient, aged sixty-five years, after exposure in a storm, in which his clothing became wet and no change was made, was seized with violent pain in the abdomen, which was at first confined to the right iliac fossa and subsequently became diffused. Very great distention, with absence of fecal dejections, the presence of ster-

coraceous vomiting, and, at one period, subnormal temperature were prominent symptoms, and pointed to conditions more serious than fecal impaction. On two occasions consultations were held, and the question of the performance of laparotomy was discussed. At each time it was decided to persevere in the treatment, in which the employment of large injections and systematic kneading of the abdominal wall, with the application of a strong galvanic current, took important part. At the expiration of the twelfth day the obstruction was overcome, and the function of the bowels reëstablished. It appeared evident that the obstruction was not due to fecal impaction alone, and I feel confident that laparotomy in this case would have seriously complicated it, if it had not caused fatal consequences.

As I have said, in discussing this question, I think that we should confine ourselves simply to the question of the conditions in which we should feel justified in opening the abdominal cavity for diagnostic purposes. There are many conditions which we are unable to diagnosticate without this operation. When the diagnosis is otherwise impossible, then I agree with Dr. Johnston that we should make it by abdominal section.

I think that we should take into consideration the conditions which require treatment. I agree with Dr. Vanderveer that we should open the abdomen in many cases of intestinal obstruction. I believe that many lives have been lost in these conditions for want of courage on the part of the surgeon. I believe that we should operate in gunshot wounds of the abdomen involving the intestines. In these cases there is no question about our duty of opening the abdomen and treating the condition. When, however, we come to consider the question of opening the abdomen for the purpose of simply making a diagnosis, I think that we should hesitate and should insist that all other methods should first be tried. Not only should we observe ourselves, but we should teach that skill should be cultivated by means of external examinations and such internal examinations as we may be able to make, and that these be employed before resorting to this operation, which is not devoid of risk.

There are conditions of the peritoneum which make operations upon the abdominal cavity more grave at one time than at another. I have lost a patient in two or three days after an operation for the removal of the appendages of the uterus for myomata, where the injury to the peritoneum was, comparatively speaking, slight. I have, on the other hand, had serious injury to the peritoneum with the removal of large

growths, in which the patients have recovered without any evidences of septic conditions. So in cases where there are no morbid conditions present, but where it is simply an operation for exploration with the finger, we frequently subject the patient to greater danger than when there are large growths which have been exerting pressure upon the abdominal walls, seriously interfering with the circulation of that portion of the abdominal cavity. We should in all cases consider these conditions.

Dr. Charles T. Parkes, of Chicago.

There is scarcely anything left for me to say in regard to the paper of Dr. Johnston. I certainly considered that the paper was such as to establish the proposition that all other points in the examination had been exhausted previous to the resort to the operation of laparotomy, whether it be a case of intestinal obstruction, gunshot wound, or other pathological condition of whatever kind; that all other means of diagnosis had been passed over, and, finally, as frequently happens, the question comes to be, What can we do further? It is then the question of letting the patient die, or, passing to the further diagnostic measure, that of resorting to laparotomy.

I have noted two points which arise in this paper. One is with reference to the size of the incision. So far as my experience goes, I think its length makes little difference as affecting the final recovery; but where I have been obliged to prolong the incision above the umbilicus, the patients have passed through a slower process of recovery, when they have recovered. There has been in these cases some little trouble with the wound or with the stitches.

In connection with the mortality attending incision of the abdomen, I shall merely relate my experience. So far as exploratory incision in my experience goes, whether the exploration has shown conditions leading to a continuance of the operation or not, I cannot say that the abdominal section had anything to do with the final result. Where death has followed, and an autopsy has been made, nothing has been found in the condition of the abdominal incision that would act as a cause of death. I cannot help referring, in this connection, to a case which opened my eyes as to the danger of opening the peritoneal cavity. A woman had received an injury by being horned by a cow. The horn passed through the upper portion of the mons veneris, entered the abdominal cavity, and made its exit in the neighborhood of

the margin of the ribs. From both openings intestine protruded. This case not only illustrates the fact that lacerated wounds of the abdomen get well, but also the fact that a large body can enter the abdominal cavity without doing any injury to the contents. This case was treated very simply. The wounds were cleansed of foreign bodies and sutured. A drainage tube was introduced to allow the escape of any accumulation. The patient recovered during the hottest weather of summer, amid the worst surroundings, without even a circumscribed peritonitis. It seemed to me at that time if a wound of this kind could get well so readily, that the wound made by the surgeon is an extremely simple thing and should not deter us from proceeding further.

I desire to put myself on record in regard to intestinal obstruction with reference to the procedure said to be recommended by Mr. Hutchinson, of London, who, it is reported, manipulates his patients and puts them through the gymnastics referred to by Dr. Vanderveer. Within the past six months, a case of this kind came under my inspection. A gentleman, with symptoms of intestinal obstruction, was subjected to this method of treatment without any relief so far as the symptoms were concerned. The pain and vomiting continued, and soon the vomiting became fecal. I saw him in consultation a short time afterward. He was then in a state of collapse so extreme that, even with my enthusiasm with reference to laparotomy, I did not advocate the procedure. The patient died soon after. At the post-mortem, the cause of the obstruction was found to be a band of dense adhesion extending from the brim of the pelvis near its middle, over to the margin of the sacral promontory, into this and beneath it extended quite a mass of small intestine. It required a considerable amount of force to remove them. No one can tell whether it is volvulus, intussusception, or internal strangulation which leads to the obstruction, and it seems a terrible thing to advocate the plan of submitting the patient to harsh external manipulations for conditions of which the surgeon knows nothing. After exhausting all the usual methods for overcoming the obstruction, if you please, emptying the stomach with the exhaust pump, filling up the intestine, the use of mild manipulation, etc.; these measures having been exhausted, and it being a question between death and interference, I agree with the essayist that it is the bounden duty of the surgeon to open the abdomen in such a case and try to relieve the trouble. So many cases have been followed

by relief that the surgeon cannot get out of the necessity for the operation.

With reference to resorting to the operation when the exhaustion is extreme, I believe that there are no other cases in which success in the presence of great shock will follow so certainly as in these cases. A few years ago I saw a case of intestinal obstruction of nine days' duration. The obstruction was complete, notwithstanding the most active interference. There was fecal vomiting and the patient was in a condition of extreme collapse. The pulse was scarcely perceptible and the surface was bathed with cold perspiration. The abdominal cavity was opened and immediately beneath the fingers was felt a small cyst which, under slight pressure, ruptured, discharging offensive pus into the abdominal cavity. The patient recovered rapidly after its removal. In such a case the best diagnostic skill could not have determined the cause of obstruction, which was simply the pressure of this abscess changing the direction of the ileum.

I had another case which did not result in recovery. An infant of eighteen months had presented the usual symptoms of obstruction for two or three days: vomiting, absence of discharges from the bowel, but there was no distention of the abdomen. The presence of a tumor in the ileocæcal region was easily determined. The friends opposed any operative procedure, and the child was allowed to die. The post-mortem examination showed it to be the simplest kind of an intussusception of the small into the large intestine. There were no adhesions. In that case I positively believe that abdominal incision would have saved the child's life.

So far as interference in cases of abdominal wounds with perforation is concerned, it is hardly necessary for me again to state my opinion. Neither external nor internal examination will do any good. It certainly is only possible to save these cases by operation. I am inclined to doubt the truth of the report of any case in which recovery is said to have followed a wound of the abdomen with perforation of the intestine without operation. In my opinion, there is no other procedure to be adopted but to open the abdominal cavity and to open it in the median line. In no other place can the contents be reached so readily. Within the last year I have seen a case of perforating wound of the abdominal cavity where the result of the operative procedure was a failure mainly because the wound made by the ball was enlarged some distance from the median line. The man died and the post-mortem showed the cause of death to be an unfound perforation of the intes-

tine. Three or four openings had been sewed up, but the last one was not closed and around its margin was the fecal extravasation. All operations on the abdominal cavity should, I think, be performed through the median line, the freedom of the incision depending upon what the surgeon expects to find, without reference to its effect upon the patient.

In a paper of this extent it is impossible for those who discuss it to follow out any other line than that which is presented by their own individual experience. I certainly am opposed to the plan of uniting the peritoneal wound by a series of separate sutures. After having subjected a patient to a formidable operation such as opening the abdominal cavity for the relief of intestinal obstruction, or for the closure of intestinal wounds, or for the removal of large tumors, with or without adhesions, I think it unjust and improper to prolong the shock to the patient for the length of time which is necessary to close up the different layers of the wound separately, when it has been proven that the simple suture going through all the tissues has been followed by such good results.

With reference to the point raised by Dr. Mears as to the pathological condition of the peritoneum in cases of abdominal tumors where they concern the uterus and appendages, the result being more fatal in removing the uterus, perhaps because the peritoneum has not been so much inflamed as in other pathological conditions. I believe that this does not depend upon the condition of the peritoneum, but upon the method of treating the pedicle. In ovarian tumors the rule is to drop the pedicle, but in the case of uterine tumors there is a large mass which, if dropped into the peritoneal cavity, is apt to produce subsequent trouble there, and which, if left outside, begets great trouble in the wound. Here, I think, is the difficulty, and not in the peritoneum itself.

I should like to say a word about the condition of distention of the intestine. I think that the method mentioned by Dr. Vanderveer as being resorted to by Mr. Tait, and which is advocated by Mr. Treves —that is, of making an incision in the most prominent coil of intestine—is the best. I have used the exploratory needle on several occasions to relieve the distention of the intestine. This opens only a small section of the tube, and it is necessary to repeat the puncture a number of times, which prolongs the operation and increases the danger. In two instances, the post-mortem examination showed that the punctures had not closed, and as a result, when the intestine collapsed, there was

extravasation of the contents of the intestinal canal around the neighborhood of the perforations. I have resorted to it a number of times without harm, but as it is beyond the control of the surgeon and as there may be extravasation when the canal collapses, I am in favor of making a considerable opening and closing it immediately.

Dr. VANDERVEER. I did not intend to wander from the subject, and I did not intend to bring in anything more than seemed necessary in discussing a paper covering so much ground.

In reference to the remark of Dr. Mears in regard to opening the abdominal cavity and exploring it with two fingers, I must say that in this Mr. Tait excels. He does more in half a minute than can any one else. I do not want to convey the impression that I would do the operation recklessly. Let every method be faithfully tried for the relief of intestinal obstruction, but let us do the operation sufficiently early to give the patient a chance. I have had two unfortunate cases, one was for the removal of the uterine appendages for the relief of a soft uterine myoma, where the patient had such hemorrhage that all means of arresting it failed. Finally, operation was recommended. The operation was done six months ago. The patient died of exhaustion within forty-eight hours. She consented to the operation reluctantly, and did not react. I failed to remove the appendages because they were attached to the uterine tumor.

The other case was one of pelvic peritonitis, from which the patient suffered very much. The operation was advised by Mr. Tait. I did the operation, but the patient died of peritonitis within three days. Beyond these cases, I have no reason to regret performing the operation. The remarks of Dr. Parkes confirm me in the opinion that it is a justifiable operation.

Dr. L. McLANE TIFFANY, of Baltimore.

Many questions have been raised by the essayist. Laparotomy is not simply a question of incision of the walls of the abdomen, and as such is not to be considered. Laparotomy is undertaken when the patient is ill and when the powers of life are depressed, and in addition to that depression there is not simply an incision of the abdominal walls, but the operation involves inspection and manipulation of its contents, and in a number of cases some surgical procedure, so that the term laparotomy should include these various manipulations. In many

cases the patient is, unfortunately, in a condition of extreme depression, in a profound state of collapse; I say unfortunately, because the operation is not undertaken sufficiently soon. Especially is this the case in intestinal obstruction.

Since the last meeting of the Association I have been called in consultation with four cases of what I believe to have been instances of intestinal obstruction. In all, laparotomy was offered to the patient, the operation was declined by two, and both patients died. In two the operation was accepted, and one of the patients recovered. In the two cases which died, I could not obtain an autopsy. One of the cases operated on was a woman aged seventy-three years, the obstruction having lasted seven days. I operated, found the obstruction in the descending colon, and relieved it. The obstruction was produced by a peritoneal band. The intestines were enormously distended, and with great difficulty I had found where the obstruction was, when the intestine ruptured. The rest of the operation was as plain as though I had had the intestine on the dissecting-room table. The bowel was sewed up, but the patient died the night after the operation. I think favorably of incising the bowel to permit the escape of gas. The difference in the ease of the operation in my case was very great. With the intestines distended, I searched for ten minutes before I found the obstruction. The cause of the obstruction, as I have stated, was a peritoneal band situated at the splenic flexure of the colon.

The other case, which I saw in consultation, was operated on by the physician. It was not necessary to insert the hand into the abdomen. An incision a couple of inches long was made, the fingers put in, the obstruction found and relieved. The patient recovered. The manipulation of the intestine in these cases is, I think, one of the causes of death. I am inclined to believe that incision of the presenting loop of gut is good practice as facilitating the operation and relieving shock. I believe that it will produce less shock to empty the gut and operate on the collapsed intestine than to manipulate and operate on an alimentary canal which is largely distended with fecal matter, of one kind or another, and with gas.

In regard to the earliness with which the operation is performed, I think we all agree, but I do not believe that it is possible to lay down any rigid rule. The early date at which the operation is done, must rest upon the acumen of the physician who sees the case. It is not the education of the public. It is the recognition by the profession at

large as to the necessity for the operation and the recognition of how soon the patient passes beyond the power of medicines.

The title of the paper is excellent. At the last meeting of the Association, an extremely interesting class of cases were reported by one of the Fellows in regard to the operation for gall-stones, and at that time I stated that I thought that in the great majority of operations upon the belly the opening of the abdomen was a diagnostic operation. I now believe this more than ever. It is not possible for any human being to recognize, through the abdominal walls, the manifold conditions of the organs present. I do not believe that, in the early stages of grave affections, the opening of the belly is so very dangerous. In the later stages, it does produce death. In my case recently mentioned, the patient died because I opened the belly. Death was hastened by the operation. This is a responsibility which every surgeon must accept. I do not think that it is the public that is to be educated, but the general profession. The physician must recognize that the administration of opium is not continuously beneficial, and that a time comes when the belly must be opened. The earlier the physician recognizes that an operation will assist him, the more successful will the operation become. The physician does not turn his patient over to the surgeon, he simply coöperates with one who is perhaps a little more skilful than himself in the use of instruments.

I should like to record a case of which I saw the post-mortem conditions only. It is the only case that I know of, of intestinal obstruction from retroperitoneal hernia. A large mass of bowel passed back of the peritoneum and was incarcerated behind the transverse colon. The examination was made for medico-legal purposes. The patient had been stabbed and the wound healed, but he died a week afterward from internal strangulation, something entirely unconnected with the previous injury.

There is another condition which calls for laparotomy on general principles, but in which it is absolutely useless. It belongs to the category of intestinal obstruction. The case which I shall relate was described to me by the physician who attended it. A woman of middle age was seized with the symptoms of intestinal obstruction; purgatives did not act. The belly became swollen, there was little or no vomiting at first, but in three or four days it appeared. Large injections of soap and water were made use of, and the patient said that she tasted the injection in her mouth and spat up what were said to be soapsuds. The patient lived some time, but finally died. At the post-

mortem no obstruction was found. There were, however, about eight inches of the small intestine of a bright scarlet color, soft and flaccid, and unable to propel its contents either up or down. It was supposed to be a case of localized enteritis. I thought then, and still think, that possibly this was a case of embolism of one of the mesenteric branches. Just as we have extreme congestion of a portion of the lung producing the pulmonary apoplexy of the older writers, so I thought that possibly this section of gut was supplied by a branch of the mesenteric artery that had become the seat of an embolus.

One more point in regard to gunshot wounds of the belly, about which much has been written, but about which there is still much to learn. Of military practice I have no knowledge. Since the war I have seen numerous gunshot wounds of the belly in civil practice, and have recognized the complete impossibility, on my part, of knowing when the abdominal contents were injured. In the large majority of bullet wounds from pistols in civil life, so-called, the balls are small, and I think the bowel escapes. I want to put on record a most notable case where the patient was shot in the abdomen; the aorta was perforated but the other abdominal contents were uninjured. This patient lived six days with two holes through the aorta. In these cases, it is a question to determine when the operation should be done. We are at present without the means of deciding positively. The opening of the belly is, I think, not going to do any additional harm; at the same time, the operation may lead to the death of the patient. I think that we are not in a position to formulate any positive rule. I think that the opening of the belly in a dirty place and under uncleanly conditions is most wrong. Where this can be avoided, it should be. We have hospitals having rooms for tracheotomy, and patients operated on in those rooms do better than those operated on under other conditions at home; so hospitals should have rooms for operations on the abdomen. Under such circumstances we should have a greater percentage of recoveries.

Dr. J. Ford Thompson, of Washington.

I wish merely to mention two cases of exploratory incision made during the past year at the Garfield Hospital. In the first case, the operation was done for the purpose of diagnosis. The patient was a woman thirty-five years of age. There was a history of abdominal tumor extending over several years. The abdomen was about the size of the

fifth month of pregnancy, and the tumor presented the appearances of an abdominal tumor. There were two sinuses, one on the right and the other on the left. After she had been examined by the members of the staff, there was a decided difference of opinion. Some thought it connected with some of the abdominal viscera, others that it was the result of inflammation in the abdominal walls, while still others thought that it was a tumor in the abdominal walls which had suppurated. After several consultations and examinations, it was decided that I should operate. I began with the sinus that led to the right and cut down to the peritoneum without discovering anything. I found no pus cavity, although for two or three years there had been a slight discharge of pus from these sinuses. I then opened the peritoneal cavity to the right of the median line, and introduced my hand. It readily passed behind the tumor. The abdominal wall was apparently enormously thickened. I then thought that my first diagnosis, that it was an inflammatory affection of the abdominal wall, was correct. The opening was then closed and the woman recovered from the operation. At the time she was in a bad condition of health. She died five months after the operation, without ever having had a symptom referable to the exploratory incision. At the autopsy I found a condition which I have never seen described. The spleen had fallen down into the region of the pubic bone, become inflamed and was attached, extended up toward the umbilicus and presented these two sinuses. That was a case of laparotomy for the purpose of making the diagnosis, but the diagnosis was not made. It may be thought that the diagnosis should have been made without operation.

The second case was one that happened a few months ago. There was a small tumor in the right hypochondriac region. At first it appeared to be the size of an egg. It was apparently movable, and very painful and tender. I kept the patient under observation for several months and had several consultations. The woman and her husband finally begged that I should operate, and, if possible, determine the nature of the tumor. I made an incision three inches above the umbilicus, introduced my fingers and seized the tumor, which I was able to bring into view. I found, as I supposed, that it was a carcinoma. My diagnosis had been carcinoma of the mesentery, probably involving the transverse colon. The tumor surrounded the transverse colon. It had also involved the liver, being attached to it by a continuation of the growth, two inches in diameter. No nodular enlargement of the liver itself could be detected. It was impossible

to complete the operation. If the growth had been confined to the colon, I should have resected a portion of the gut. The woman recovered from the operation and is living to-day.

In wounds of the abdominal contents, I think that it is a decided advantage to open the abdomen in the median line. The Fellows must remember that Billroth prefers, in all his operations upon the stomach, the incision along the floating ribs.

Billroth invariably closes the wound by what he calls the button suture, and for a time I thought that this was a good plan. I believe that closing the wound with two or three sets of sutures is a decided advantage, and I cannot agree with those who believe that the old way is the best. There is more danger of abscess in these cases, and if the stitch passes into the abdominal cavity, there is danger of pus following along the track of the suture. In the last two operations that I have performed, I have used these separate sets of sutures with great satisfaction. I used them in a case of ovariotomy with a number of complications. The case resulted fatally, and at the autopsy the peritoneal wound was found perfectly healed. The peritoneum was united with catgut sutures; catgut was used for the second layer, and silver for the skin. The advantage of this method is that the peritoneal surfaces are at once united, and even if suppuration should occur along the second line of sutures the pus is outside of the peritoneal cavity and the abscess may be opened with impunity. From the present point of view, these sutures possess certain advantages. As to the material which composes the suture, it is impossible to determine from the experience of operators what is the best substance. Billroth uses very fine silk, and in intestinal operations it is, perhaps, preferable.

Dr. W. H. Carmalt, of New Haven, Connecticut.

In illustration of the importance of this subject, I will simply relate the result of a case in which I now think a laparotomy should have been made, but which, to my regret, I did not make it. The patient had been in the New Haven Hospital for eighteen months with hemiplegia, confined to her bed, except when she was lifted to a chair alongside of it occasionally. While in this condition and without any assignable cause, she was attacked with symptoms which, in the course of a few days, pointed somewhat suspiciously to intestinal obstruction, though there was not entire occlusion of the bowel. After exhausting all other means of relief I was asked to operate. The patient did not

seem then in an immediately precarious condition and I decided against interference at that time. She continued in about the same state, having two movements of the bowels in the course of the next three days, when a condition of collapse came on rapidly and she died in a few hours. The autopsy showed a rupture of the greatly distended ascending colon at a point about five inches from the ileocæcal valve, and an obstruction at about fifteen inches from the same point caused by a band of fibrous adhesion which had dragged a portion of the omentum and the whole of the transverse colon down into the pelvis, causing the latter to take a U-shape with the branches parallel to the ascending and descending portions of the colon respectively. This parallelism was most marked with regard to the descending portion, the parts here lying in almost direct contact down to the sigmoid flexure. The twisting of the parts was so complicated and the bands of adhesion were so firm that it took a good deal of time at the autopsy to unravel them. No such examination as could be made with two fingers introduced through the wound in the abdominal wall would have accomplished much in the way of diagnosis, and a larger incision, with considerable manipulation, would probably not have relieved her; but as the patient died of the perforation of the bowel caused by the obstruction, I have been very sorry since that I did not make the attempt, and I think it is our duty when discussing a new method of procedure, certainly when such nicety of judgment must be exercised, that we relate the unsuccessful as well as the successful cases, especially if we can get the results of the post-mortem examinations.

Dr. Mears. I have only this to add to my remarks, to place myself on record, if I have not been fully understood, that I make a distinction between laparotomy as a means of diagnosis and laparotomy as a means of treatment. I understood that we were to discuss simply the question of laparotomy as a means of diagnosis. I am in accord with those who have spoken with regard to laparotomy as a method of treatment. If necessary, I would open the abdomen from the ensiform cartilage to the pubes as a means of treatment in conditions demanding it. With reference to laparotomy as a means of diagnosis, we should endeavor to cultivate other methods and turn to laparotomy as a means of diagnosis only as a last resort, and only after all other means of diagnosis have failed. Where the diagnosis was obscure, and I had exhausted all other means, I should not hesitate to perform laparotomy, but I should also be prepared to perform any operation on the cavity that might be

required. By simply opening the abdomen and closing it after having made the diagnosis, the condition involving a subsequent operation, we should subject the patient to dangers which would not be justifiable.

Dr. JOHNSTON. I am not in the least surprised at the unanimity of surgeons with regard to diagnostitial laparotomy. I think that the etymology of the word was a little misunderstood by one of the speakers. Laparotomy really means a cut in the flank. Dr. Thompson would probably have completed the diagnosis in his case, if he had made the incision in the median line. Laparotomy is used in two senses, first, to signify an incision in the belly, and then to include the entire operation. We sometimes hear that such a thing was done by laparotomy; we should rather say "through laparotomy." It is the gate which lets us see the condition present, and the operation depends upon what we discover.

Dr. Mears has rectified a little error as regards laparotomy as a means of diagnosis. I do not wish it to be thought that I use laparotomy without having first employed the other means of diagnosis. This operation is frequently repulsive to the attending physician and to the family of the patient. As a matter of course, after the diagnosis is established the operation ought to be done.

There are some modes of diagnosis of which I do not think so well. They have to be undertaken with caution. Dr. Mears has spoken of puncture of the belly. In gynecology, it is the rule that when aspiration is performed, the operator should be prepared to do immediately what is necessary in the premises, for aspiration may lead into much greater danger than is supposed in the beginning. Aspiration is not always safe in connection with many abdominal tumors.

There is another point on which I lay much stress; that is, when the patient presents himself to the surgeon, he is in such a condition that all other measures except laparotomy and what follows, are out of the question. If the surgeon do the operation and succeed, he gains a life; if the patient die, he loses nothing, for the patient would have died if the operation had not been performed. In proper hands, it is all gain and no loss.

With regard to the case related by Dr. Tiffany, I could not catch the exact diagnosis. I would ask what the condition was.

Dr. TIFFANY. The diagnosis was intense congestion, probably due to acute enteritis, of about eight inches of the small bowel.

Dr. JOHNSTON. Without offence, I may say that a great number of that sort of cases have been supposed, on good authority, to have been cases of intussusception. We know how often death releases the intussusception. I would throw out the conjecture that if diagnostitial laparotomy had been performed, such a condition might have been found, and the patient would have died none the more for the operation.

With regard to these cases, I would also say that there is a certain hesitancy on the part of the surgeon, and a shrinking from the opinion of people and the decision of jurists, and I do not wonder. Juries, with regard to physicians, are formidable combinations. Where the profession adheres together, its opinion must be accepted. I think if we would show more love for the profession by fraternally loving and supporting each other, the fear of juries would become a small thing. At present this is a factor and an element in regulating the action of physicians, who must also abide by the decision of the family. Surgeons must, however, educate the public as to the true state of affairs. In certain of the cases related, the operation might have resulted in a cure, especially the cases of perforation of the bowel. Do these cases ever terminate favorably? They mean certain death. To confirm or make the diagnosis that the bowel has been opened, laparotomy should be done. This leads us to the seat of trouble, and if anything can be accomplished, it can be attempted then and there.

I did not propose to consider the treatment of the wounds made. I would only say with regard to the triple suture to which I alluded in connection with a case, that I think the matter should be referred to the individual knowledge and experience of the surgeon who does the operation. Some operators prefer one line of sutures, while others prefer two or three. Everything should be done according to the best knowledge of our art.

Dr. Parkes alluded to a very interesting case, which I should like to supplement by referring to one which occurred in Baltimore, in which Dr. Randolph Winslow opened the belly and found the intestine constricted by an adhesion some six inches in length, which he divided; the patient recovered.

There is one word concerning what Dr. Parkes has said with reference to the size and location of the incision. I do not doubt that the incision carried above the umbilicus would lead to more serious consequences than an incision from the pubic bone to the umbilicus, but we are not always able to choose the location. The seat of disease is

sometimes better reached by the upper than by the lower incision. Most surgeons agree that the median line is the one to be preferred. Dr. Thompson has referred to the line of incision obliquely along the lower border of the ribs employed by Billroth in reaching the stomach. The probable reason why he selected this incision is that he thought that he could reach the pylorus better in this way. He succeeded. When one has a child, he cares more for it than for other people's children. Probably Billroth adheres to this incision on this account, although the general profession accept the median incision as ordinarily the best.

In conclusion, I will say that I am happy to find my views supported by so many able men in the profession.

A CONSIDERATION OF THE BACTERIA OF SURGICAL DISEASES.

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[Read by invitation.]

VERY many observations have been made, extending over a long space of time and by many different observers, with the object of determining the etiology of the pus-forming processes in man. Before our knowledge of bacteriological methods was as precise as is now the case, such experiments as those of Councilman (Virchow's *Archiv*), and others, were considered to be conclusive. These experiments showed, or seemed to show, that the introduction of simple irritant substances into the animal tissues was sufficient to set up a more or less marked degree of irritation, followed by suppuration and the production of a localized or sometimes of a general purulent process. The materials used were croton oil, turpentine, and the like, and the results observed after their introduction into animals were ascribed to a specific power which they possessed, which could, and generally did, produce pus-formation when such materials came in contact with animal tissues. These experiments seemed conclusive at the time they were published, but with our more recent and intimate knowledge of the bacteria, their fallacies are easily to be perceived, and are seen to lie very largely in the imperfect methods taken to prevent the activity of bacteria, and the fact that these latter were not sought in the lesions produced, by means which would lead to their detection if

present. It is not surprising, therefore, to read the results of Klemperer in his admirable paper upon this subject (*Zeitschr. f. klin. Med.*, Bd. x. S. 158, and *Fort. d. Med.*, 1886, S. 34). Thinking, and with apparently good reason, that the results of other observers might be due, in part at least, to the imperfect sterilization of the *skin* of the animals experimented upon, this author made all his inoculations at a point which had been just previously seared with a red-hot iron, and again used the actual cautery at the point of inoculation after the operation was over. Of course, the syringe and material employed were thoroughly sterilized in the usual way. Experiments were made in large numbers, with acids, alkalies, cantharides, mustard oil, petroleum, and other irritating materials, and upon rabbits, guinea-pigs, and mice. Pus formation *never* occurred; at the most, the only sign of any local or general disturbance being a moderate localized serous effusion. After the use of croton oil or mercurial injections, there occurred in some cases a firm necrotic (diphtheroid) infiltration—Weigert's acute coagulation-necrosis. In only three of a large number of cases did suppuration occur, and in all of these cases micrococci were found in the pus, and the observations were therefore considered imperfect.

The observer concludes that the strongest chemical cannot produce suppuration without the presence of bacteria, and his results certainly seem to support this view. He found also a micrococcus, which under ordinary circumstances would produce no suppuration upon inoculation into animals, but which would set up a flow of pus if an irritation were produced such as would result after the introduction of acrid materials into the tissues.

Scheuerlin (von Langenbeck's *Archiv*, Bd. xxxii. Heft 2) has also investigated this question, and has come to the same conclusion as Klemperer, that no suppuration will occur without the presence of microörganisms. His method of experimentation was to place from one to four drops of the irritating substance in capillary tubes. These tubes were sealed, sterilized in the moist chamber, and introduced under the skin of rabbits with all possible antiseptic precautions. When the incision

made for their introduction was thoroughly healed, taking six days as a rule, the tubes were broken under the skin, and the animals were killed in from four to eight days. Thirteen irritating substances were used, such as oil of turpentine, croton oil, oil of mustard, formic acid, etc., with distilled water as a control. In only one case was suppuration observed, and bacteria were found in this one.

The point being determined, therefore, that there is at least a very strong probability that no suppuration occurs without the presence and activity of bacteria, the study of the organisms concerned in these processes becomes at once of great interest.

Pasteur was one of the first to investigate the subject, and his "vibron septique" was one of the first of the organisms connected with a septic process with anything like certainty (*Bull. de l'Acad. de Méd.*, 1877, p. 793). Since that time "the micrococcus of pus," and like expressions, have been commonly employed as denoting a single organism which might be held responsible for all purulent processes, but with unreasonable inaccuracy, as later investigations have shown. In other words, there is not one but a number of pus-producing bacteria, which have been fairly well identified and described, and there is no reason to suppose that this number will not be added to as the investigations in this direction are proceeded with.

Rosenbach was the first observer to differentiate more than one variety of pus-forming microörganism in man ("Microorganismen bei den Wundinfektionskrankheiten des Menschen," 1884), and was quickly followed by Krause, Passet, Hoffa (*Fort. d. Med.*, 1886, S. 75), and others, working in the same direction. Of course, the pioneer in this as in most other of the exact work in modern bacteriology was Koch, who gave indications of the direction and methods of research in his classic "*Wundinfektionskrankheiten*."

Of the bacteria concerned in pus-formation which have been found in the human body, and shown to possess pathogenic properties by inoculation experiments upon animals, there are at least twelve varieties which have been described with sufficient accuracy to make it possible for any observer to identify them.

This identification, however, is not a simple matter of staining reaction and microscopic observation, as is the case with the bacillus of tuberculosis, but includes all of the means adopted for the classification of microörganisms from a bacteriological point of view—not, however, from a botanical standpoint.

The "points" of any bacterium, which form collectively the diagnostic evidence of its place in the classification, are, 1, its form, size, and arrangement; 2, its power of motion or not; 3, its behavior upon the three great classes of culture-media, nutrient gelatine, nutrient agar-agar, and solidified blood-serum, including the form and color of the colonies, and its appearance upon plate cultures; 4, the temperature at which it flourishes best; 5, the rapidity of the development of the colonies; 6, whether it produces spores or not; 7, whether or not air is necessary for its growth—aërobic or anaërobic; 8, whether it produces gas or not; 9, its behavior in gelatine—that is, whether it does or does not liquefy the nutrient gelatine; 10, its behavior toward staining materials; 11, its pathogenic properties when inoculated into the lower animals.

All of these points must be investigated when it is desired to obtain complete evidence in regard to any special bacterium, and sometimes it is necessary to go through them all before it can be determined that it is one rather than another variety which may be under observation. From this statement it may be easily seen that it is occasionally a difficult matter to say with what organism a given observer has been working.

Rather than to run over all the work of each one separately, in order to give a clear idea of what has been done by the various observers in this line of investigation, I have thought it best to give a summary of the various bacteria thus far found in the "infectious wound diseases" of man, according to the above method of classification. In this way it seems to me as if a clearer idea of them could be conveyed than by any other hasty method.

1. In the first place comes the Staphylococcus pyogenes aureus, very abundant in pus, first described by Rosenbach ("Mikroör-

ganismen bei den Wundinfektionskrankheiten des Menschen") and Passet ("Ætiologie der eiterigen Phlegmonen des Menschen"). They are cocci of variable size, occurring in masses, and often as diplococci, of an average diameter of 0.87 μ. On agar-agar, at 37° C., they grow as a glistening raised colony, 2–4 mm. broad, of a bright orange color. This color may often appear only after some time, and is then accompanied by a smell like that of sour paste. In gelatine, there is generally a cloudy, grayish streak, which after about three days becomes of a yellowish, finally orange color, and liquefies the gelatine, into which the colony sinks. By a needle plunged into agar-agar there is presented a cloudy, beaded yellowish line, which becomes opaque after twenty-four hours, and later of an orange color. There is a layer 3–4 mm. broad, extending over the surface of the agar-agar about the point of entrance of the needle. On sterilized potato the colony has an orange-yellow centre, with a thin, whitish, almost transparent border, which gradually becomes thicker and yellow. There is also the strong paste smell. Its growth in blood-serum is exactly as upon agar-agar. It grows best at from 30°–37° C., somewhat more slowly at summer temperature. It retains its vitality for a long time without oxygen, and produces no gas formation. It liquefies nutrient gelatine, and produces an orange-yellow pigment. Injected into the peritoneal cavity of rabbits and other animals, it will produce death after twenty-four hours, or else a tremendous suppuration which may last ten days or more.

This and the micrococcus of osteomyelitis (Becker, *Deut. med. Woch.*, 1883, No. 46) are probably identical, because the behavior of the two under cultivation is the same; they are the same under the microscope, and the results after inoculation are the same.

2. The Staphylococcus pyogenes citreus found in pus, and described by Passet (l. c.), has precisely the same properties as the preceding, except that its colonies are colored lemon-yellow instead of orange-yellow. It is not nearly so common as the Staphylococcus aureus.

3. The Staphylococcus pyogenes albus (Rosenbach, l. c.)

occurs in pus less frequently than the S. p. aureus, and has the same morphological characteristics and similar pathogenic properties, but in a milder form, producing, as a rule, only localized abscesses when introduced under the skin of the lower animals.

4. The Micrococcus pyogenes tenuis (Rosenbach, l. c.) occurs in large subacute abscesses mostly, and is a form of micrococcus somewhat larger than the staphylococci, without regular arrangement. It grows on the surface of agar-agar, as a thin, almost transparent layer, and in the substance of the same material its growth is almost imperceptible. It grows very slowly, does not liquefy gelatine, and occasionally some of the larger ones are stained at the two poles by the aniline dyes employed, leaving the centre almost clear.

5. The Staphylococcus cereus albus (Passet, l. c.), found in pus, is a micrococcus of irregular size, occurring in masses, or occasionally in chains; it grows on plate cultures, with nutrient gelatine as white points 1–2 mm. broad. In gelatine, the surface of the colony is grayish-white, with thick stearin-like drops along the needle track. On potatoes there is a grayish-white colony of medium thickness, and on blood-serum a grayish-white dull streak. It does *not* liquefy gelatine.

6. The Staphylococcus cereus flavus (Passet, l. c.) is exactly like the preceding, except that it produces a lemon-yellow color somewhat darker than that of the S. p. citreus previously described. It is of very rare occurrence.

7. Bacillus saprogenes No. I. (Rosenbach, l. c.) is a rather large bacillus containing prominent spores found by Rosenbach in the white plugs of the follicles of the tonsils. On agar-agar the colony appears as a yellowish-gray opaque streak about 1 mm. thick, of cheesy, sticky consistency, with irregular edges after some time, and after four or five weeks a foul smell like that of sour cake. It is of very slow growth, produces large spores, and gives out an intensely foul odor when free access of air is allowed—when air is excluded the growth is retarded, and the foul smell is delayed in making its appearance. Inoculation into the knee-joint of a rabbit gave a negative result.

8. The Bacillus saprogenes No. II. (Rosenbach, l. c.), found in

the material from foul-smelling feet, is somewhat smaller than the preceding, and, after twenty to twenty-four hours, the colony on agar-agar appears as numerous fine points which enlarge and coalesce, and form first an irregular clear, and then opaque, tough slimy layer. The smell is that of foul feet. It grows very rapidly, is aërobic, and also facultatively anaërobic, and gives its characteristic odor much more quickly by the free access of air then when this condition is wanting. It seems to have *mild* invasive and pyogenic properties.

9. Bacillus saprogenes No. III. (Rosenbach, l. c.), found in the pus of septic gangrene, on agar-agar after eight days at summer temperature, appears as a colony 3 mm. broad, of an ash-gray color, not sticky, but of an almost fluid consistency, with a rounded contour. It grows with medium rapidity, reaching its maximum in eight days. There is very rapid fouling of albumen with free access of air—without this, the process is slower; all culture-media except milk produce this foul smell in the presence of this organism. After injection, either subcutaneously or in the joints of a rabbit, there occurred a yellowish-green infiltration with a surrounding redness, as well as the characteristic foul smell.

10. Bacillus pyogenes fœtidus (Passet, l. c.) was found in abscesses about the anus, and consists of short staffs with rounded ends, often occurring two or more together, with an average length of 1.45 μ, and a breadth of 0.58 μ. It has slight motion. Plate cultures in gelatine show, after twenty-four hours, white points, later becoming grayish-white. Magnified twenty diameters, the colonies appear thick and white in their centres, and thick and gray at the edges. In gelatine in tubes, after twenty-four hours, there is a soft, grayish-white, slimy layer on the surface, with rather thick, irregular edges. The needle-track is softened at first, and later presents large and small points all along it. Old cultures cloud the gelatine at the upper portions. On potato there is a glistening luxurious growth of a clear brown color; on blood-serum, a thick grayish-white streak. It grows rapidly, and does not liquefy nutrient gelatine. Subcutaneous injections and those into the abdominal cavity produce death in

guinea-pigs and mice after twenty-four hours. The bacilli are found in the blood, but not at the point of inoculation nor in the organs.

11. Streptococcus pyogenes (Rosenbach, l. c.) was found in the pus of an erysipelas-like process. It is a micrococcus occurring in chains of from two to thirty, and of from 0.58–0.73 μ in diameter. On plate cultures in gelatine it produces fine round granular points. *In a streak of the needle*, the culture is thickest at the middle, of a light brown color; its contour becomes thicker, swells up, and finally assumes a terraced form. Needle punctures in gelatine show a delicate layer around the entrance of the needle, the needle-track itself presenting fine points of growth, at first very sparse but later larger and much more numerous. In agar-agar at 35°–37° C., there is a string-like grayish-white line with points all along it, and no surface layer. On cooked potato it does not grow well. On blood-serum it grows along the needle-track as a thin string-like colony. It grows best at 35°–37° C., much more slowly at summer temperature. It grows slowly, the colony being but 2–3 mm. broad after two or three weeks in surface culture. After four months the culture is almost dead. It may be renewed in fresh nutrient material. It will decompose albumen in a vacuum, does not liquefy gelatine, and upon inoculation in animals produces a very severe spreading erysipelas-like suppuration.

12. Streptococcus erysipelatis (Fehleisen, Die ætiologie des erysipelas), found in the lymph-channels during erysipelas, is a small micrococcus occurring in pairs or in chains, especially upon cultivation in bouillon, of about 0.3–0.4 μ in diameter. On plate cultures with gelatine it occurs in fine round granular colonies. Needle cultures in gelatine, after twenty-four hours, show very fine white points or flecks the length of the needle-track, which later become a homogeneous white streak. There is either no, or very slight growth upon the surface of the gelatine around the point of entrance of the needle. In agar-agar it grows very sparsely over the whole surface, in small, almost imperceptible colonies. On blood-serum at 37° C., the

colony is almost exactly of the color and nearly indistinguishable from the serum itself. It develops best at from 20°–30° C., grows slowly, and produces, in rabbits, a sharply defined spreading redness, without suppuration. It always occurs in the lymph-channels of the skin in erysipelas. It has been tried in a number of cases on man, and in these produced a typical erysipelas.

13. Bacillus pyocyaneus (Gerrard, De la pyocyanie et de son microbe, 1882), found in green pus, is a short, fine rod, very likely to be mistaken for a micrococcus. In plate cultures with nutrient gelatine, after two or three days, the whole of the plate has a clear green tint, the colonies liquefying the gelatine in a funnel-shaped depression. Under a low power the colonies appear round, somewhat yellowish, and glistening with clear granular edges.

Needle cultures in gelatine, after twenty-four hours, liquefy the upper layer of the gelatine in a funnel-shaped depression, with a fluorescent coloring of the upper portion. The liquefaction later extends out to the side of the test-tube, and the whole of the gelatine takes on this clear fluorescent appearance. In agar-agar there is a moist, greenish-white colony, whilst the whole of the agar-agar is colored with a diffuse fluorescence. On potato, dry colonies of a rust-brown color appear, which turn green with ammonia and red with acids. It grows rapidly ; will not grow under mica (glimmer platte), and liquefies nutrient gelatine. Guinea-pigs die after cultures of this organism have been injected into the abdominal cavity (Koch). Rabbits survive its injection into the blood-current.

14. Pneumoniacoccus like bacillus (Pneumokokken aihnlicher Bacillus, Passet), an organism found in pus occurring as micrococci—*very rarely* as short staffs—in contradistinction to the pneumoniacoccus of Friedländer, which very often has this form. On plate cultures, small grayish-white nodules appear, made up of the cocci. Needle cultures in gelatine show, after twenty-four hours, a grayish-white hemispherical nodule on the surface, with no growth in the body of the nutrient soil. After three or four weeks there appear a brownish color in the

gelatine and a foul odor. On potato, at 37° C., there is a thick, soft, whitish, glistening layer, with no gas production. Its growth is rapid, it produces no gas, and does not liquefy gelatine. Injected into serous cavities it produces a suppurative process, but has almost no effect after subcutaneous inoculation. It has no result at all in inhalation experiments.

This summary includes all the organisms which have yet been described with a sufficient degree of accuracy to permit of their classification, and which have been found in the purulent or inflammatory processes in man. It is made up from the work of the various observers spoken of in the earlier part of the paper, and is based upon the excellent tables of Dr. Eisenberg. It does not, of course, include those organisms described by Koch in his "Wundinfektionskrankheiten," because they were connected solely with the lower animals by that observer. The summary gives us, however, a very comprehensive view of the work that has already been done and of the number of organisms which have already been found in the various suppurative and inflammatory processes occurring in man. Unquestionably the subject is not yet exhausted, and additions to this list may very probably be made.

I have been interested in examining such cases as I could gain access to, of graver forms of the suppurative process than simple acute abscesses and the like. These latter have been investigated in such numbers by the observers already alluded to —Rosenbach, Krause, Passet, that it hardly seemed worth while to go over exactly the same ground again in the same way. I have selected, therefore, so far as was possible, severe cases, of long-standing, and those where there had been no access to the air previous to the time of examination. Cases of this sort, fulfilling all the indications required, are not especially easy to find, and my thanks are due to Drs. J. C. Warren and E. H. Bradford, for the material which they have placed at my disposal.

In chronological order the cases which I have examined are as follows:

I. Cultivations were made from an abscess of slow growth

occurring at the seat of an ununited fracture of the left humerus of over a year's standing. No external injury to the parts was apparent, and there was no opening until the incision was made through which the pus was obtained for cultivation. Cultures were made from the pus which flowed out and from the wall of the abscess. Colonies of the Staphylococcus aureus and albus made their appearance upon the nutrient material in the course of a few days, were separated from each other, and carried through a number of generations. This case is interesting because the diagnosis of tuberculosis was made from the clinical symptoms, but a very careful examination of cover-glass preparations of the pus and of scrapings from the wall failed to show any indication of tuberculosis either in the way of giant cells or of the bacilli of tuberculosis.

II. A large perinephritic abscess of several weeks' duration. Cultivations made from the pus and from the abscess wall showed the presence of the Staphylococcus aureus and albus, which were separated and grown for some time. The case terminated fatally from pyæmia, and micrococci corresponding to those in the cultivations were found in microscopic preparations of the valves of the heart, in the kidney, spleen, and blood.

III. A skin disease of the knee in a girl of twenty, of some years' standing. An incision was made through the growth, a flap turned back, and cultivations made from beneath this by scraping the needle over the surface. The colonies which made their appearance were the Staphylococcus citreus and albus, which also were separated and carried through a number of generations. Sections were made of a portion of the diseased skin of the knee which had been put into absolute alcohol at once after removal. Micrococci corresponding in size to those in the cultures were found in large numbers just below the layer of flat epithelium, with colonies running down at frequent intervals between the cells into the deeper layers of the skin. The microscopic appearances in gross showed the presence of giant cells and granulation tissue, with some proliferation of the epithelial cells into the deeper parts with a few clusters of epithelial cells. The most careful search through a number of

sections, by Dr. W. F. Whitney and myself, failed to show the bacilli of tuberculosis.

IV. Perinephritic abscess of several weeks' duration, with a small opening which was only a few hours old. The abscess was opened by an incision through the skin made upon the opposite side of the body from this sinus, and cultivations were made upon agar-agar from the pus thus obtained. Pure cultures of the Staphylococcus aureus made their appearance in the course of a few days.

V. Erysipelas of the foot four days old surrounding a penetrating wound. An incision through the skin at a point just beyond the line of redness was made, and cultivations were sown with a platinum-needle from over the bottom of the wound. A pure culture of the Erysipelas coccus was obtained.

VI. Cultivations were obtained from the material in the vagina of a case of vaginal diphtheria after parturition at the Boston Lying-in Hospital, through the kindness of Dr. W. L Richardson. There appeared, in the course of a few days, colonies of the Staphylococcus albus, and of the Bacillus pyogenes fœtidus—the latter of which I had hoped to be the first to describe, but which will be seen, by the preceding mention of it, to be credited to Passet.

VII. A case of vaginal diphtheria occurring under the same circumstances as the preceding. Cultivations made in the same manner were productive of colonies of the Staphylococcus albus only. The case was almost convalescent at the time the examination was made.

VIII. A third case of vaginal diphtheria under like conditions as the two preceding, with the exception that there was a considerable amount of pus present in the vagina. This patient also was convalescent. The culture tubes showed the presence of the Staphylococcus aureus and albus, and of the Bacillus pyogenes fœtidus. There was also present a bacillus resembling the Bacillus subtilis, which was probably due to some contamination occurring during the manipulations.

IX. A case of psoas abscess in a child—a large amount of pus. Opened under carbolic spray and cultivations made from

the pus and from the abscess wall. The result showed a very free growth of the Staphylococcus albus only.

X. A case of hip disease in a child, with a profuse suppuration about the hip-joint. Cultivations made from the pus as it flowed from the incision and from the joint itself showed the presence of the Staphylococcus aureus and albus. The latter—S. albus—was much the most prominent, S. aureus appearing in only one tube out of ten in which cultivations were made.

XI. A case of hip disease in a child—with sinuses which had been open for some time. In this case cultivations were made from a fresh opening made to secure drainage and a free development of the Staphylococcus aureus and albus, and of a fine oval bacillus with no pathogenic properties was obtained—the latter was probably the so-called Bacterium termo. The Streptococcus pyogenes was also found in this case, making four, in all, which were obtained.

XII. A case of glanders in the human subject. The body was covered with a large number of pustules, three or four of which were opened and cultivations upon agar-agar and in gelatine were made, the point at issue being to discover whether any of the ordinary forms of bacteria present in pus would be found in this case. As a result, colonies of the Staphylococcus aureus and albus were obtained, as well as two or three colonies of a fine bacillus answering the description of the organism found in this affection by Gaffky.

XIII. A case of lumbar abscess with possible caries. Cultivations made from the pus flowing out after incision of the abscess resulted in the development in a few days of a number of elevated, glistening, yellowish colonies which, upon microscopic examination, were found to be made up of pure cultures of very fine, short, straight bacilli.

XIV. Psoas abscess in a child. Cultivations from the pus obtained in this case showed the presence of the Staphylococcus cereus flavus of Passet, so-called, and of the Staphylococcus aureus.

XV. Psoas abscess in a child. Cultivations from the pus of this case gave, as a result, colonies of the Staphylococcus albus,

and of a bacterium, of which a more detailed description will be given further on.

XVI. A case of abscess of the arm in a man. There was extensive purulent infiltration over the region of the shoulder and upper arm, extending into the left side, and penetrating into and between the various muscles of the affected parts. A number of cultivations were made with the pus as it flowed out from the freshly opened wounds, and in the course of a few days very beautiful colonies of the Streptococcus pyogenes were obtained.

XVII. Abscess of the back following caries of the spine, which had existed for some time. The abscess was apparently the size of the fist, of rapid growth, and was situated in the right lumbar region very near the spine. Cultures were made from this case as before, from the pus flowing from a freshly made incision. After a time, slowly developing colonies of the Micrococcus pyogenes tenuis were seen to make their appearance, together with colonies of the Staphylococcus pyogenes albus.

XVIII. A case of bubon d'emblée. The swelling was of slow growth, and absolutely no history of venereal infection could be obtained. There were signs of pulmonary solidification, however, and the question as to whether the swelling in the groin might be of tuberculous origin or not, became of interest. Upon incision into the tumor, a thick, dark pus was forced out, and cultivations were made, which, in the course of a week, produced colonies of the Staphylococcus pyogenes albus and of the Micrococcus pyogenes tenuis. Two of the glands which were enlarged to the size of marbles, were placed in absolute alcohol, and upon several subsequent occasions sections were stained and examined with the greatest care for the presence of bacillus of tuberculosis; the results of such examinations were in all cases negative.

This completes the list of the cases which I have examined. It is not an extensive one, and was purposely, so far as possible, limited to the more chronic processes, and to those where there was and had been no access to the air until the moment of

time during which the cultivations were completed. It is, however, important to observe that in every case examined one or more forms of bacterial life were developed upon the nutrient material, and, therefore, that so far as these observations go, they tend to refute the assertion that bacteria are not present in the more chronic forms of purulent disease. It is true that they may not be discovered by simple microscopic examination of the fresh pus, but this does not prove that they are not present. Their numbers may be so small that a few cover-glass preparations made up from only a portion of a drop of the pus might easily fail to reveal their presence. Cultivations, however, offer a means for their development, and the presence of but one or two bacteria may be demonstrated in this way, in cases where they might be overlooked if any other method of investigation were employed.

In all the cases that I have reported, the mode of procedure was as follows—except, of course, in the diphtheritic vaginæ, where there was necessarily more or less free access to the air. After anæsthesia was complete, the skin over the point selected for the incision was thoroughly washed in a solution of corrosive sublimate, 1 : 1000; the surgeon's hands were sterilized in the same solution. The incision was made with a knife freshly removed from the same solution, and as soon as the pus-containing cavity was opened, a platinum needle taken from the flame of an alcohol lamp was plunged into it, and test-tubes containing nutrient gelatine and nutrient agar-agar were inoculated with the material obtained. The tubes were then removed to the laboratory, and in some cases plate cultures were made at once, and in others not until twenty-four hours afterward. A portion of the tubes was also placed in the incubator at 37° C., and the conditions of development were observed under these circumstances. Every one of the bacteria obtained was identified by means of its microscopic appearances, and its behavior under cultivation in various nutrient media on plate cultures with nutrient gelatine, on agar-agar, etc., so that no name is given to any of the organisms found in the cases reported without a sufficient basis of careful observation.

A large number of the bacteria were propagated through from fifteen to twenty generations, and were found to preserve their properties under cultivation during the whole of the time they were under observation, extending from six months to over a year. Owing to my absence abroad during last fall, and an unfortunate mistake in regard to the time of my return, a number of the cultures were lost through drying. By this I do not mean that all of any one variety were lost, but that about one-half of the collection I had made from different cases were destroyed. This was to be regretted, because I had kept every bacterium from every case separate, and had carried each one through a long number of cultivations extending over a great length of time, with a view to the determination of differences, if any existed, in the pathogenic powers of microörganisms from different cases, but of the same apparent nature, as shown by their appearances under varying conditions of cultivation. This point—the accident which I speak of—prevented me from investigating, although the results obtained by other authors seem to indicate that there is no such difference as had seemed to me possible when I began this research; and the fact seems to be established that the differences in the pathological changes produced by what we must call the same bacteria, are the result of influences other than those peculiar to the bacteria themselves, such as changes of nutrition and method of infection. It is to such differences as these that the varying clinical results produced by the Staphylococcus pyogenes aureus, as seen in osteomyelitis and acute abscesses, must be ascribed, for it seems to be fairly well established that the organisms producing the first and a part of the latter processes are identical. The methods of Koch, including, of course, the employment of solid culture media, have been used in all cases as being conducive to greater precision and more definite results than any others that are known. This is especially the case in such an investigation as the present one, for without these methods the differentiation of the various bacteria in the pus-producing processes would be practically impossible.

Inoculation experiments have been made in considerable

number to test the pathogenic powers of the various organisms which I have had under observation. Here, again, the method employed has been that of Koch. The place selected for the inoculation has been first thoroughly cleansed and then soaked in a solution of corrosive sublimate (1 : 1000), the hands of the operator have been sterilized with the same solution, and for inoculation a syringe, like the one I have here, has always been employed. It may be readily taken apart and cleansed, has no packing or other parts to become foul, and may be subjected to any temperature required for sterilization. In all cases these syringes have been subjected to 150° C. for an hour just before being used. The material for inoculation has been prepared in the case of cultures in gelatine media by simply melting the gelatine, pouring it into a sterilized capsule, and then using the required quantity in the syringe shown; or, when the cultures were upon nutrient agar-agar, by placing a portion of the culture in boiled distilled water and using this in the same way as the liquefied gelatine cultures.

The animals used were all selected for their apparent condition of good health, had all been under observation for some time before the operations, many of them having been kept in the country miles away from other animals, and were all kept under the very best possible hygienic conditions. The result of these precautions is seen in the fact that in no single case did the post-mortem examination reveal any abnormal condition of affairs that might not fairly be attributed to the activity of the bacteria which had been injected.

The animals employed were guinea-pigs—mice were excluded because symptoms produced in them are not fairly comparable to those obtained in larger animals, and rabbits could not be obtained in Boston at any price during the time that I was carrying on my inoculation experiments.

The bacteria with which I have experimented are the following:

The Staphylococcus aureus and albus.

The Staphylococcus pyogenes citreus.

The Erysipelas coccus.

The Streptococcus cereus flavus.

The Streptococcus pyogenes.

The Micrococcus pyogenes tenuis.

The Bacillus pyogenes fluorescens.

The records of the inoculation experiments are as follows:

Inoculation experiments with the Staphylococcus pyogenes aureus.

I. A full-grown healthy guinea-pig inoculated in a vein of one leg made prominent by partial constriction. Two drops of a pure culture in gelatine of the sixteenth generation of the Staphylococcus aureus from the first case reported (ununited fracture of the arm) were employed. The cultivations had been conducted out of the body for over a year. Death occurred in less than twelve hours. The autopsy showed very little change in the internal organs—the heart was much distended and full of fluid blood. Cover-glass preparations showed the blood to contain numerous micrococci, and cultivations made from the blood in nutrient gelatine showed the presence of the Staphylococcus aureus.

II. An adult guinea-pig inoculated with the same culture as the preceding, under the skin of the abdomen—two cubic centimetres of the cultivation in gelatine being used. Killed in ten days. An abscess the size of a marble, filled with thick yellowish pus, was found just under the point of inoculation,. Cover-glass preparations of this pus, and sections of the abscess wall, showed the presence of large numbers of micrococci. Cultivations were made in gelatine and upon agar-agar (37° C.) from the abscess, from the blood, and from the peritoneum. Very free growth of the Staphylococcus aureus was obtained from the first, but neither the cultivations nor cover-glass preparations from the blood or peritoneal cavity showed the presence of any bacteria whatever.

III. A guinea-pig inoculated with the same amount and material as the preceding, except that the inoculating needle was plunged deep into the abdominal cavity. Dead in ten hours. Examination showed only a marked redness about the point of inoculation, and that the needle had not penetrated the intestines. The heart was much distended with fluid blood.

Cultivations were made from the point of inoculation, the peritoneal cavity, and the blood of the heart, and liver, and spleen in gelatine and agar-agar. No growth appeared in any of the tubes except those sown from blood, and this growth proved to be the Staphylococcus aureus.

The contrast between the results of the last two experiments is very marked—in the first case, the organisms being found only in the abscess and not in the blood, and, in the second case, being only in the blood and not about the point of inoculation. In the first case the effect was purely local, and in the second it was general and of a septicæmic character.

IV. Staphylococcus pyogenes aureus from a perinephritic abscess (Case II.), seventeenth generation cultivated for over a year. Two cubic centimetres of nutrient gelatine containing a culture were injected under the skin of the back of a guinea-pig. Killed in four days. An abscess about an inch long by one-half inch broad, and three lines in thickness, full of thin yellow pus, was found just beneath the skin. Cultivations made from this showed the presence of the Staphylococcus aureus, and microscopic examination showed masses of micrococci in the pus and in the abscess wall. Cultures from the blood gave no result whatever.

V. The same amount and material were employed as in the preceding experiment, and the inoculation was made subcutaneously over the abdomen. In two days death occurred. Section showed a very marked congestion of all of the abdominal viscera, with an abscess about one-half inch in diameter at the point of inoculation. Cover-glass preparations of the pus and sections of the abdominal wall showed the presence of masses of micrococci, whilst cultivations in nutrient gelatine and on agar-agar gave abundant growth of the Staphylococcus aureus. Cultures of the same organism were also obtained from the blood, and cover-glass preparations of the blood showed it to contain a number of micrococci.

VI. Staphylococcus aureus, from a perinephritic abscess (Case IV.), eighteenth generation, cultivation extending over eight months. Two cubic centimetres of a culture in nutrient gelatine

were injected into the abdominal cavity of a healthy guinea-pig. Killed on the fourth day. The animal was moribund. Section showed the presence of an extensive purulent peritonitis, and microscopic examination of the pus together with cultivations made from it demonstrated the presence of the Staphylococcus aureus. Cultures from the blood and microscopic examination of the same revealed absolutely nothing abnormal; no bacteria were found.

VII. Staphylococcus aureus. The same experiment as the preceding was performed in the same way, and with the same result, except that the animal was killed on the second day. The inflammatory process with the suppuration seemed to be, if anything, more extensive. The same results were obtained by microscopic and cultivation experiments; the Staphylococcus aureus was found in the pus but not in the blood.

VIII. Staphylococcus aureus, from a psoas abscess (Case XIV.), the twelfth generation, cultivation out of the body extending over seven months. Four cubic centimetres of a solution in distilled water of one drop of a pure culture in nutrient gelatine were injected into the abdomen of a healthy guinea-pig. In two days a swelling the size of an English walnut could be felt under the point of inoculation. Killed at the end of twelve days. The remains of an abscess were found, the cavity having almost closed; only a few drops of thick yellowish pus were obtained. Microscopic examination of this, however, showed it to be a mass of micrococci, with a small proportion of cell nuclei. Cultivations from this material gave only a feeble growth, which was afterward determined to be the Staphylococcus aureus. Cultures from the blood remained sterile.

IX. Staphylococcus aureus. The same generation and solution as in the preceding case were employed, but only one cubic centimetre was injected. There was no result observed. The animal was killed on the fourth day, when only a slight redness at the point of entrance of the inoculating needle could be made out. Cultures made from the blood and from the peritoneum remained sterile.

X. Staphylococcus aureus. Two cubic centimetres of the solution used in the two preceding cases were injected into the knee-joint of a full-grown guinea-pig (right posterior). Death on the following day. Cultures from the blood and from the joint gave a free growth of the Staphylococcus aureus; the joint itself showed no suppurative action, but was the seat of intense redness, with great swelling and some infiltration of blood. A small vessel had undoubtedly been ruptured during the inoculation and some of the infective material had in this way got into the blood current.

XI. Staphylococcus pyogenes albus, from an abscess at an ununited fracture of the humerus (Case I.), fifteenth generation, cultivated out of the body for thirteen months. Two cubic centimetres of a culture in nutrient gelatine were injected under the skin of the back of a full-grown guinea-pig. On the second day a slight swelling was observed at the point of inoculation. The animal was killed on the fourth day, when section showed nothing abnormal in the abdominal or thoracic viscera. There was an abscess under the skin at the point of inoculation, about two centimetres in diameter, filled with quite fluid pus, of a distinctly lighter color than that found in any of the preceding experiments. There was not much change in the tissues about the abscess; a very slight swelling, extending one or two millimetres from its boundaries, being all that was noticeable. Cultivations and microscopic examinations showed the presence of the Staphylococcus albus in the pus and in the abscess wall, but not in the blood.

XII. Staphylococcus pyogenes albus. The same generation and cultivation were employed as in the preceding case. A drop of a culture in nutrient gelatine was placed in ten cubic centimetres of water, and two cubic centimetres of this were injected subcutaneously over the abdomen. The animal was killed on the fourth day, but no bacteria were found, and the point of entrance of the inoculating needle was barely visible except upon close examination.

XIII. Staphylococcus pyogenes albus, from a perinephritic abscess (Case II.), twelfth generation. In this and the following

experiment, XIV., two cubic centimetres of a pure culture in nutrient gelatine were injected subcutaneously over the abdomen. Both guinea-pigs were killed at the end of a week. In both were found small abscesses at the point of inoculation, from one to three centimetres in diameter, and filled with a thin yellowish-white pus. Cultivations showed the presence of the Staphylococcus albus in both, but in neither of them was anything found in the blood.

XV. Staphylococcus pyogenes albus, from a diphtheritic vagina (Case VI.), thirteenth generation, cultivated outside of the body for nine months. A minute portion of a cultivation in nutrient gelatine (one-half of a cubic centimetre), with two cubic centimetres of freshly boiled distilled water, was injected subcutaneously in the right abdominal region of a guinea-pig. A small lump was felt under the point of inoculation upon the following day. The animal was killed at the end of ten days. The lump had apparently decreased in size, for, upon section, it was found to be barely as large as a pea, and contained a few drops of thin pus. Microscopic examination showed that there were large numbers of micrococci in the pus, and in the walls of the abscess. Cultures in nutrient gelatine and upon agar-agar showed that they were the Staphylococcus albus.

XVI. This experiment was a simple repetition of the preceding. The same culture and the same amount were used in the same way, and the results were precisely the same.

XVII. Staphylococcus pyogenes albus, fourteenth generation, from a case of diphtheria of the vagina (Case VII.), cultivated outside of the body for over nine months. One cubic centimetre of a solution of a culture upon agar-agar in distilled water was injected deep into the muscle of a leg of a guinea-pig. The animal was killed at the end of six days, when a clearly defined abscess, about three centimetres in diameter, was found lying between the muscles, with practically no inflammatory tissue surrounding it. The pus was of the usual character, fluid, and of a rather light yellow color. Cultivations made from it gave colonies of the Staphylococcus albus, and micro-

scopic examinations showed many micrococci in the pus and abscess walls. Neither of these methods of investigation gave any result when applied to the blood and internal organs.

XVIII. Staphylococcus pyogenes albus. The same cultivation and from the same source was employed in this as in the preceding case. A larger amount, however—five cubic centimetres—was injected subcutaneously in the left abdominal region. The next day a very marked swelling could be seen, and upon the third day this swelling broke through the skin and commenced to discharge. Section showed a large abscess just below the joint of inoculation. Cultivations gave the Staphylococcus albus, and two varieties of bacteria, which were probably the result of contamination from the air, especially as sections of the abdominal wall showed micrococci only.

XIX. Staphylococcus pyogenes albus, cultivated from a psoas abscess (Case IX.), fifteenth generation, propagated outside of the body for more than nine months. One cubic centimetre of a culture in nutrient gelatine was injected under the skin of the back of a guinea-pig. The animal was killed on the sixth day, when an abscess the size of a small marble was found at the point of inoculation. Cultures from the pus gave a free growth of the Staphylococcus pyogenes albus; nothing was found in the blood and internal organs.

XX. and XXI. The same cultivation was used in the same quantity for inoculation into the abdomen of two other guinea-pigs. They were examined on the fifth day, and in both of them localized abscesses were found at the seat of inoculation, which were shown to contain the Staphylococcus pyogenes albus by cultivation experiments, and by microscopic examination of the pus and of the abscess walls.

XXII. Staphylococcus pyogenes albus, from a psoas abscess (Case XV.), fourth generation, grown outside of the body for about three weeks. A guinea-pig was inoculated on the top of the head with two cubic centimetres of a culture of this organism in nutrient gelatine. A slight swelling the size of a pea made its appearance at the end of the first twenty-four hours. Examined on the third day, an abscess about two centimetres

by three in dimensions was found just under the skin, and not involving any of the deeper tissues. It contained the Staphylococcus pyogenes albus, as demonstrated by cultivation experiments.

XXIII. and XXIV. The same organism from the same source carried through four more generations, making the eighth, was injected into the abdominal cavity of two guinea-pigs, one cubic centimetre being used. Examination upon the seventh day. In one of the animals a small abscess, the size of a pea, containing a few drops of light yellow pus, was found lying just below the stomach. The abscess was clearly defined, and the neighboring structures were not involved. In the other animal an abscess about twice the size of the preceding was present just above and in front of the bladder. This also was as definitely defined as the other. Cultivation experiments showed the presence of the Staphylococcus pyogenes albus in both lesions.

XXV. Staphylococcus pyogenes albus (Case XVIII.), from an abscess of the inguinal glands, third generation, cultivated out of the body for three weeks. A guinea-pig was inoculated with one cubic centimetre of a culture of this organism in nutrient gelatine. The inoculation was subcutaneous and in the dorsal region. The animal was killed on the sixth day. An abscess, three centimetres in diameter, was found under the skin, at the point of inoculation, and microscopic examination showed the walls and the pus to be full of micrococci, which upon cultivation were seen to be the Staphylococcus albus.

XXVI. The fourth generation of the same organism employed in the preceding experiment was used to inoculate a guinea-pig in the abdominal cavity, one cubic centimetre of the culture in nutrient gelatine being the quantity injected. It was killed on the third day, when, as in the other cases, an abscess was found lying in the abdominal cavity just anterior to the kidney and without implication of any of the surrounding tissues. Cultures from the pus it contained showed the presence of the Staphylococcus pyogenes albus; cultures from the blood gave no result.

XXVII. This experiment was the same as the preceding, and gave the same results in every particular.

XXVIII. Erysipelas coccus (Case V.), twenty-second generation, cultivated outside of the body for more than a year. A minute portion of a colony on nutrient agar-agar was diffused in sterilized distilled water, and two cubic centimetres of the mixture were injected into the skin of the top of the head of a guinea-pig, which had been previously shaved and washed with corrosive sublimate. A marked redness made its appearance on the following day, accompanied by much swelling of the skin. An incision into the skin was made, and cultivations from the edges of the wound gave a plentiful growth of the Erysipelas coccus.

XXIX. and XXX. The same generations and material were used in both cases. The inoculations were made subcutaneously in the abdominal region in guinea-pigs; they were followed by some swelling and tenderness of the skin and general languor and disinclination to movement. Section on the third day showed marked emaciation everywhere, and much congestion of the skin of the abdomen, with some œdema. Cultures made from the skin showed the Erysipelas coccus in abundance, and sections of the infiltrated tissue were found to contain numbers of these organisms lying in the lymph-channels and between the cells of the deeper layers.

XXXI. Staphylococcus pyogenes citreus (Case III.), twentieth generation, cultivated out of the body for over a year. Two cubic centimetres of a culture in nutrient gelatine were injected into the abdominal cavity of a guinea-pig. The animal was killed on the fourth day, when a slight infiltration about the point of inoculation was found, but no suppuration and no bacteria could be demonstrated anywhere in the animal body.

XXXII. The same material in the same amount was employed for injection into the abdominal cavity of a second guinea-pig. The animal was killed on the second day, when an abscess the size of a pea was found among the intestines which were adherent to its borders, and the whole abdominal cavity was much

congested. Cultures from the pus in the abscess and from the blood gave colonies of the Staphylococcus pyogenes citreus.

XXXIII. A small portion of a culture of the same organism upon nutrient agar-agar was mixed with four centimetres of sterilized distilled water, and two centimetres of the mixture were injected under the skin of a guinea-pig in the abdominal region. The animal was killed on the third day, when an abscess about two centimetres in diameter was found at the seat of inoculation. Cultures from the pus of this gave colonies of the Staphylococcus citreus, but nothing was found in the blood.

XXXIV. Staphylococcus cereus flavus (Case XIV.), seventh generation, cultivated out of the body for six weeks. This organism is one described by Passet ("Untersuch. ü. die articl. der eitengen phlegmonen des Menschen," Berlin, 1885), and which he considers to be active in the production of suppurative processes. He was, however, unable to produce any specific results in inoculation experiments with it, and the two which I made likewise gave negative results. The experiments were alike in character, and consisted in the injection into the abdominal cavity of guinea-pigs of two cubic centimetres of a culture in nutrient gelatine. Section of the first on the third day after the inoculation showed no result whatever, and cultivations from the blood and abdominal fluids failed to show the presence of any bacteria. The (XXXV.) second guinea-pig, killed on the second day, gave equally negative results, neither macroscopic, microscopic, nor bacteriological observation showing the presence of anything abnormal. The negative evidence to be offered in the case of this bacterium does not, therefore, permit us to say that it has any pathogenic properties which can be demonstrated by ordinary methods; the only fact which is known is that of its rather uncommon occurrence in suppurative processes. Passet's specimen was found in a case of chronic suppurative periostitis of the ulna in a phthisical male subject twenty-seven years of age. Mine occurred in the case of psoas abscess in a child which was supposed to be connected with disease of the spine.

XXXVI. Streptococcus pyogenes (Case XVI.), sixth genera-

tion, cultivated out of the body for six weeks. One cubic centimetre of a culture in nutrient gelatine was injected into the shoulder of a guinea-pig. In two days, examination showed extensive infiltration of the muscles about the point of inoculation, with free suppuration and a collection of pus in the axilla. Cultures from the places affected gave colonies of the Streptococcus, and microscopic examination of the pus showed the organism in large numbers.

XXXVII. and XXXVIII. One cubic centimetre of the seventh generation of the same organism was injected into the abdominal cavity of two guinea-pigs. They were found almost moribund on the morning after the inoculation. Section showed an extensive inflammation over the whole abdominal cavity, with slight suppuration compared to the extensive nature of the process. Cultures from this region and from the blood of the heart gave abundant growth of the Streptococcus.

XXXIX. The same generation as was employed in the last two cases was used in this one. A very minute portion of a colony upon agar-agar was mixed with water and injected subcutaneously into a guinea-pig. Section upon the third day showed an extensive suppurative infiltration beneath the skin, extending out in all directions from the point of inoculation. The lymphatics all through the abdominal cavity were much congested, as were the spleen, liver, and kidneys. Cultures from the pus and from the blood in each of the organs, as well as from the heart, gave free growth of the Streptococcus pyogenes.

XL. Micrococcus pyogenes tenuis (Cases XVII. and XVIII.). Cultures of this organism were made as related in the account of the cases from which they were obtained. The fourth generation from (Case XVII.) an abscess of the arm was inoculated (1 c. cm. of culture in nutrient gelatine), after cultivation for three weeks, subcutaneously in one guinea-pig, with no result. The third generation, from Case XVIII., a "bubon d'emblée," was injected in the same quantity and in the same way into a guinea-pig. Section in three days showed a very slight infiltration of the tissues about the point of inoculation, but cultures from this

situation remained sterile. Microscopic examination showed a few of the organisms lying in the infiltrated portion of the tissues; so very few however, as to be exceedingly difficult of detection.

In speaking of Case XV.—a psoas abscess in a child—mention was made of an organism which was found in the cultivations from that source which presented certain peculiarities under cultivation, which I believe have not yet been spoken of by other observers. It first attracted attention by the peculiar green fluorescence which it imparted to the gelatine culture medium throughout the entire diameter of the test-tube, whilst it did not liquefy the gelatine, in this respect differing from the bacillus of green pus, which does produce liquefaction of that material. The only other organism with which it can be confounded by the macroscopic appearances of its cultures is the *fluorescent bacillus*, which produces the like pigmentation of the gelatine culture medium. This color extends beyond the limits of the colony, and bacteria are not found in it, and it seems to be due to the action of some product of the growth of the organism upon the nutrient material. In fact, so far as I have yet investigated this bacterium there appears to be no difference between the appearances of its cultures in nutrient gelatine, agar-agar, and blood-serum, the main point being that, so far as I am aware, the fluorescent bacillus has no pathogenic properties, whilst the organism which I am describing seems to have a very active influence upon guinea-pigs. Microscopically, the differences are marked, however, for this organism is a short bacillus, appearing singly, in pairs, and in chains from 0.3 μ to 0.4 μ in length, whilst very often its appearance in the tissues is that of a long rod, it being exceedingly difficult to decolorize the chain in this situation, just enough to show the individual members. It grows well at the ordinary temperature of the room, much more rapidly at 37° C. It does not liquefy gelatine, but produces a grayish-white line in the track of a needle, and in a few days a marked greenish-yellow fluorescence extending throughout the substance of the nutrient material. On agar-

agar it produces in from thirty-six to forty-eight hours a grayish-white colony, elevated above the surface of the material, which has a peculiar soft, glistening appearance. The same greenish-yellow fluorescence makes its appearance throughout the substance of the culture medium. Plate cultures made in nutrient gelatine show round points of a whitish color in two days or more; the gelatine is not liquefied, and very soon presents the same greenish-yellow fluorescence as when the cultivations are made in test-tubes.

The limits of time at my disposal have been so narrow that I have not been able to investigate this organism as thoroughly as I should wish. What I have said of it is merely a preliminary description, which I hope to fill out more in detail at a future time, and will merely mention, in addition, the inoculation experiments which I have made with it.

A guinea-pig was inoculated in the abdominal region (subcutaneously) with two cubic centimetres of the sixth generation of this organism in nutrient gelatine. It died on the following day. On section four to six hours after death, there was no localized suppuration, but the entire front of the body was as dry as if there had never been any fluids there. The skin could be readily lifted from the underlying tissues without any dissection whatever, and the muscles, particularly the pectorales, were as distinct from each other as if they had been carefully separated and all the intermuscular substance removed. In fact, the appearances were those of commencing putrefaction; there was a slight œdematous condition of the subcutaneous cellular tissue of the back. Cultures from this œdema, from the blood of the heart, and from incisions in various organs, gave colonies of the organism of which we are speaking. A little later, eight guinea-pigs were inoculated in the same way as the preceding, with the eighth generation of this bacterium. Section, in from four to six days, gave uniformly the result which is illustrated in these specimens. Nothing was found at the seat of the inoculation, but in every case the liver and spleen were found to be enlarged and the seat of a greater or less number of small abscesses. Occasionally the kidney seemed to be somewhat

swollen also, but no abscesses were to be seen. Cultivations from the blood and from the seat of inoculation always remained sterile. Colonies from these abscesses always produced the peculiar fluorescence and microscopic appearances which I have attempted to describe. These include all the experiments which I have yet made in this direction. I have thought it well to speak of them here, because they seem to bear out my assertion that the end is not yet in regard to the isolation of new species of bacteria connected with the suppurative processes in man, and because I thought it might interest the members of this Association to have these facts presented to them.

The conclusions which may be drawn from the work here reported are as follows:

I. The cultivation experiments conducted over so long a space of time, with the successful inoculations at the end of that time, indicate very plainly the retention of the pathogenic power of these organisms indefinitely. Their virulence is just as great at the end of a year, and after being passed through a large number of generations, as it is when taken from their original birthplace.

II. Their permanence of form is also well demonstrated, their microscopic appearances and peculiarities under cultivation undergoing absolutely no alteration.

III. In order to obtain either a modification of their pathogenic powers or of their morphological properties—if this is possible at all—some different methods of observation must be used than those which have hitherto been employed.

IV. The probabilities indicate that work in this direction is not likely to be attended with much success: *a*, because no modifications have yet been observed, and, *b*, because prophylaxis furnishes the easiest and most generally applicable safeguard against the activity of these lower forms of life.

V. So far as the experiments go, they tend to show that no form of the suppurative process in man is unattended by bacteria, and that the inoculation in the lower animals of pure

cultures of these bacteria is followed by more or less acute and extensive suppuration.

VI. This conclusion—that of the dependence of the suppurative process upon the activity of bacteria—is very strongly supported by the most recent evidence of the best equipped workers in the field of bacteriological research.

VII. Very different clinical phenomena may be produced by the same organism; all of these phenomena, however, coming under the general head of the inflammatory and suppurative processes.

VIII. The differences in the results produced by the same microörganism in different individuals depend upon causes foreign to the bacterium itself.

IX. These differences are the result of differences in the amount of the infectious material received into the system, and of the locality or lesion by which it gains access, and also by variations in individual condition—the "personal equation" being a very large factor in making up the sum of any results in bacteriological work.

Certain investigations upon the resistance to various destructive reagents of some of these forms of bacteria have been made by Passet (l. c.). The organisms used were mainly the Staphylococcus pyogenes aureus and the Streptococcus pyogenes, these being selected as the most common and the most active of their class; and the reagents employed were salicylic and carbolic acids and corrosive sublimate. The results indicated the superiority of corrosive sublimate as a destructive agent, six drops of a one per cent. solution of this material preventing the development of either of the bacteria mentioned in ten cubic centimetres of nutrient gelatine, whilst it required twenty-five drops of a five per cent. solution of carbolic acid or one hundred drops of a solution of salicylic acid (1 : 300) to do the same thing.

DISCUSSION.

Dr. S. W. Gross, of Philadelphia.

The Association has to thank Dr. Ernst for his interesting, painstaking, and instructive paper, as well as for his exhibition of culture tubes and microscopical specimens. The conclusions at which he has arrived in regard to pyogenesis confirm those of the numerous observers who have preceded him in Great Britain, Germany, and France, all of which go to show very conclusively that acute suppurative processes are dependent upon vegetable organisms, and more especially on the various forms of staphylococcus.

The most interesting part of the paper to me is the reference to the chronic suppurative processes, which, as you are well aware, are not credited to the action of minute organisms. I do not remember having seen it stated that chronic suppurations were due to the same organisms, or produce acute suppurations, hence, I think that we shall have to award to Dr. Ernst the credit of having established this fact.

In some of the experiments to which he has alluded, as in the case of psoas abscess, one of lumbar abscess connected with caries of the vertebræ, and one of hip disease, there was a coincident tubercular process, which shows that these abscesses are the result of a double infection.

I have nothing more to say on this subject. It is impossible for us as clinical surgeons to discuss this paper. I only wish to add, that Dr. Ernst, in doing this work, has shown conclusively that suppuration, whether of an acute or chronic nature, is due to microörganisms.

Dr. J. S. Billings, Surgeon U. S. A.

I presume that all the members of the Association are familiar with the classification of mankind made two thousand years ago, by the Greek poet Hesiod, namely, men who know things of themselves, men who know things when they are explained to them, and men who neither know things of themselves nor when they are explained to them. In regard to work upon microörganisms, we might add a fourth class, namely, men who have done something of the work. A mere verbal statement of the difficulties gives, as I know from experience, a very imperfect idea of their magnitude. Only those who have at-

tempted to solve some of these problems by the methods in use twenty years ago, can fully appreciate the value and importance of the methods of Koch and his followers.

Some eighteen years ago, I was called upon to investigate the cause of Texas fever in cattle. I sent to Texas a number of sterilized glass tubes, sealed and drawn out at one end to a sharp point. I had these filled with blood from the diseased cattle, and again sealed. At the same time, similar specimens were obtained from healthy animals in the north. The blood from the Texas fever animals was decomposed when it reached me, and examination with the microscope showed abundant microörganisms. In some few instances these were also found in what was supposed to be healthy blood. When I attempted to experiment with these microörganisms, and to cultivate them in other fluids, I found that the whole simply ran into one form of decomposition, that of ordinary putrefaction, and that the different microbes could not be separated. In a subsequent experiment, a drop of the blood was divided by diluting it largely in the hope of finding a single microbe in a drop of the mixture, which was the improvement introduced by Lister. This, however, failed in connection with these experiments. As I have said, it is only one who has worked with these old methods and either failed, or succeeded in getting a pure culture only by accident as it were, that can fully appreciate the importance of the method with solid cultures, introduced by Koch, which is the great and real value of his work. It is not the discovery of this or that bacillus, but the giving of a new method of investigation, which is his great merit.

It was from a realization of the importance of that method, and of the desirability that physicians should be acquainted with what is in reality a very simple and not expensive technique, that I have endeavored to have such work done here in the museum, not in the way of original investigation at present, but for the purpose of having a number of the forms or apparatus used in these cultures here, and showing enough results in the museum itself to illustrate what can be done in this way. The work is under the charge of Dr. Gray, who will be glad to show the details to any who are interested. I hope to have this branch of the work enlarged when we get into our new building.

Some of the difficulties which come up in considering the probable relations between cause and effect in regard to a particular form of microörganism found in the blood, or limited to one locality in case of disease, are, first, that there does not seem to be any relation between the number of microbes present and the effect produced. As Dr. Ernst

has stated, you may look through half a dozen preparations and find nothing, and yet the culture experiments will bring out the fact that some organisms were present. This is one of the objections urged against the tubercle bacillus, that there is no relation between their number and the amount of disorganization produced.

A second difficulty is that we are by no means sure of the specific differences between these various forms of microörganisms. Dr. Ernst has told you very truly that under the same circumstances of nutrient medium and of temperature, these organisms will continue to reproduce the same forms. In the first place, however, the varieties of media which have been tried have not as yet been sufficiently numerous. We know in regard to some other forms of organisms, not pathogenic, that very small differences in the chemical constitution of the nutrient medium may produce a marked difference in the forms. Certain organisms will grow only in a fluid in which a minute quantity of zinc is present, so small a quantity as to be scarcely appreciable. Another form of microörganism will flourish only in the presence of tannic acid. If we go to the lower fungi we find the most curious restrictions to particular forms of media, so curious that it is impossible not to believe that some peculiarities in form are dependent upon a peculiarity in the media. One form of fungus is found only on old leather, another only on dead cow's horns, a third only in the seventeen-year locust. Out of a thousand species of minute fungi found in this vicinity which I have examined, some are strictly localized to one particular form of medium, and that form a very rare one. The probabilities are in favor of the view that there can be a gradual change in the form of these microörganisms by a change in the chemical composition of the medium and of the temperature to which they are subjected. With reference to further methods of investigation and the direction in which work is to be done, we have to consider these minute differences in the media in which the organisms are placed, and it is probable that this constitutes what Dr. Ernst speaks of as the personal equation. To carry out that branch of research, we have to include with culture and inoculation experiments a chemistry of which we have only the rudiments. You have seen in the *Bulletin of the French Academy of Medicine*, the paper of Dr. Gautier on "Leucomaines," peculiar alkaloids produced in health in the human body, as contrasted with ptomaines which are found after death and in disease. It does not seem probable that any hard and fast line is to be drawn between these two classes of exceedingly interesting nitrogenous compounds. Less com-

plex than the living protoplasm of the muscle and gland from which they are formed, they are still very complex, and ready to split up into simpler bodies. Some of these are produced probably by minute organisms. In fact, we have to suppose that much of the effect which these microbes produce is due, not to the mechanical presence of the organism in the blood and tissues (although occasionally there may be embolic phenomena produced, especially in the kidney by some of these organisms), but to the effect on the nerve-centres resulting from one of the products of these organisms thrown off into the blood. It is in connection with these culture methods that we have to develop a chemistry which will identify the products—the alkaloidal forms—and will help to explain some of the effects which they produce in different persons under different circumstances. It is easy to conceive, for example, that different results will be found where there is more or less urea in the blood, or that there might be a difference observed in cases where the glycogen was not fully transformed. So far as I know, no special work has been done in this direction.

Moreover, it must be remembered that the action of one microorganism modifies that of another, and that they are often associated. We must have these culture methods to differentiate one from another. The effect differs when one follows another; one may sterilize the ground for the second—it often sterilizes it for itself.

In regard to the methods of inoculation and culture, I have very little to remark. I only comment upon the form of syringe. I think that it is better and more certain to make use of an entirely separate apparatus for each inoculation, and for this reason I prefer the instrument used by Dr. Sternberg, viz., a glass bulb on a sealed tube, sharpened at one end. This is very simple and cheap.

As I said in the beginning, it is only those who have taken up this work who realize the real difficulty. You see here the successes, but we do not know the number of failures of tubes and plates, in which contamination occurs, and the culture breaks down.

Another point in regard to the extension of such experiments is the use of animals different from those which have been used heretofore. To prove that a particular microörganism is the cause of a certain phenomenon, it is necessary always to find it in the presence of that phenomenon, to isolate it and carry it through a series of cultures, so that you are sure that you simply have the descendants of the microörganism and none of the original matter taken, and then at the end of the series of cultures, to reproduce the phenomena by inoculation with these mi-

croörganisms. In regard to the specific diseases of man, we have, for the most part, to work with those which produce similar phenomena in animals and in man. We cannot usually experiment on man. It has been done in erysipelas and abscess, but for many of these experiments we have to rely on animals, and if we fail to produce the specific results in animals, we are at an end so far as our investigations are concerned. This is the great difficulty in regard to yellow fever—to find an animal subject to yellow fever. If such an animal could be found, we might go on and isolate the peculiar organism that gives rise to this disease. Thus far, the animals experimented on have been chiefly the rabbit, guinea-pig, rat, mouse, cat, and dog, which are easily procured and not too costly. It requires the use of large numbers to obtain cumulative evidence. These methods should be employed on other animals, as the monkey, and in large numbers too.

I have only one other matter to which to call attention, and that is to the importance of this class of research to practical surgical work and the great desirability that the practical surgeon shall have at his command the means of making such observations and of determining not merely the presence of some microörganism in the discharges, but of determining so far as our present knowledge will permit, the character of that particular organism and to identify it. Dr. Ernst has called attention, in his report, to several cases in which he was able to give valuable negative evidence and to state that a certain condition was in all probability not tubercular. That is what we must always act on in medicine, probabilities rarely, or never on certainties. Hence, it is of great practical importance to the surgeon that he should be able to do this work himself, or, which will be the most usual course in large cities, have at his command some one who has the knowledge and the means to go on and make such observations and give to the surgeon the specific results.

Dr. N. Senn, of Milwaukee, Wisconsin.

I am in full accord with all of the conclusions drawn by Dr. Ernst. The scope of the subject of the paper is so thoroughly treated that I believe there is nothing to be added in regard to the technique of the culture experiments and description of the germs. I wish simply to refer to a few of the conditions found in the body which predispose to infection and serve as a culture substance or medium for the localization and growth of these germs. In cases of experimental infection we have to

deal with a development of germs at the point where the injection is made or at some distant point in direct anatomical connection with the primary focus of infection. In other words, we can clearly trace the entrance of the germs, and at the same time we can study the pathological conditions, local and distant, attributable to their presence. As we observe in practice, suppuration independent of a tangible infection-atrium, we must naturally conclude that the infection takes place from within, that the germs are introduced into the circulation through slightly abraded or perhaps intact mucous membrane, and at some point localization takes place on account of antecedent conditions favorable to such an occurrence. This for the surgeon is an exceedingly important aspect. On the one hand, he is to prevent the introduction of the germs; and on the other, to secure innocuity after their introduction, by preventing, if possible, the presence of conditions which will favor localization and growth of the microbes.

The first condition normally found in the body that may be said to predispose to a localization of these germs is an anomalous structure or arrangement of the capillary bloodvessels. This is best illustrated by alluding to a familiar instance of suppurative disease—osteomyelitis. It is well known that this disease affects by preference children and young adults, and almost always originates primarily in the epiphyseal extremities of the long bones. What predisposes to the localization in this particular locality? Anatomical researches have shown that at the centres of ossification we have to deal with numerous recently formed bloodvessels imperfect in their structure, and consequently well calculated to serve as a centre for localization, by predisposing to engorgement. We also meet with a similar predisposing element for localization in the medulla, simply from the fact that the capillary bloodvessels in the medullary tissue consist only of channels, as it were, devoid of muscular walls. Other localities and a variety of pathological conditions might be mentioned where the conditions prevail, but enough has been said to show that certain states of the vascular system predispose to the arrest of pathogenic germs which otherwise might remain innocuous in the body, floating along perfect vessels, without localization taking place, and to disappear through the excretory channels without having produced any appreciable ill effects.

A second predisposing condition can also be illustrated to advantage by referring again to acute osteomyelitis as we observe it after traumatism. We all remember the beautiful experiments of Kocher and Rosenbach, where artificial fracture in animals never resulted in osteo-

myelitis and suppuration unless the animal had previously been infected with the specific germs of osteomyelitis. In these cases the osteomyelitic change invariably occurred at the seat of fracture. We should naturally conclude that traumatism induced conditions favoring the localization of the germs in the first place, and at the same time produced a medium for their growth resembling the artificial culture substance in the laboratory. We have reason to believe that pathogenic germs may remain latent in the system for an indefinite period of time until some determining cause or causes induce localization.

A third condition favoring localization is the existence of antecedent pathological products, a circumstance well illustrated by the interesting cases reported by Dr. Ernst of a combination of the tubercular and suppurative process. The germ of tuberculosis has no tendency to produce suppuration. It causes a degenerative process ending in tyrosis. When the tubercular deposit becomes the seat of suppuration, we are dealing with a double infection, due to the presence of the bacillus of tuberculosis and the pus microbes. From these remarks it is evident that it becomes the duty of the surgeon in the treatment of the various conditions calling for operative treatment, in the first place, to make a faithful attempt to prevent primary wound infection, and, in the second place, to guard against the formation of conditions within the body which might act as predisposing causes by favoring localization and growth of preëxisting germs.

I shall briefly refer to my experiments upon the pancreas during the last year. In operating on this organ, I found that the greatest danger of suppuration was experienced when I left in the abdominal cavity a devitalized portion of the pancreas. Being convinced that suppuration and putrefaction can never result without the presence of specific germs, I was sure that in every instance where suppurative inflammation occurred at the seat of operation, I had incurred traumatic infection. While I escaped suppuration in other experiments, I incurred this condition when I left a substance in the abdominal cavity which served as a culture for substance germs. It is practically of the greatest importance to recognize not only the injurious effect of the presence in the tissues of pathogenic germs, but also the conditions which must exist in the body for their growth and development. There can be no doubt, for instance, that while the abdominal cavity is kept clean—that is, when it contains no medium upon which germs can localize and develop—local and general infection are often prevented, because the

germs which may be present remain inert, and are removed in the course of time through the excretory organs.

One word in regard to the permanency of these germs. Dr. Ernst has informed us that their potency may continue for years. We have a beautiful illustration of this assertion again in cases of osteomyelitis. We know that, after an apparent cure, the germs may remain at the seat of the previous disease for an indefinite period of time. You have all observed cases of osteomyelitis in the adult fifteen to thirty years after the primary attack, which can be explained only by assuming that the primary lesion left germs in a dormant condition at the point of cicatrization, which remained latent until aroused into activity by traumatism or some additional pathological condition. In conclusion, I desire to express my hearty appreciation of the value of Dr. Ernst's paper, and impress upon the Fellows the importance of applying its teachings in practice.

Dr. David Prince, of Jacksonville, Illinois.

I shall occupy the attention of the Association for a few minutes only. There remains a slight suspicion that when pus obtained from the interior of the body is immediately examined, and no organic material, no germ, no microbic element is found, and after culture, a microbic element is ascertained to exist, there is a suspicion, I say, which was not sufficiently cleared up in the paper, that these germs might have been communicated in the process of transferrence.

I wish now to call attention to only one branch of the subject, that of prophylaxis. I am not a microscopist myself, nor have I under my charge any one capable of investigating this subject, but to the matter of prophylaxis I have paid some attention. Some years ago, I was walking with Dr. Elisha Harris past the old New York Hospital, and he told me that most of those confined in the lying-in department of it suffered with erysipelas. I was in New York a few years ago, talking with Dr. Emmet, and he said that he would not open an abdomen while an east wind was blowing. There were soap-boiling establishments on the east side of the city, and from these he thought it possible that some injurious material might be brought in the atmosphere. In 1881, I was in Glasgow, and met Dr. McEwen. I told him that I was anxious to see him operate for knock-knee. He said that they had been building an addition to the Royal Infirmary and had opened a privy, and that he had not operated since that had been opened, but that they were about closing it and that he would operate

on Thursday (this was Monday). He used the spray, but had not such confidence in it as to think that it would neutralize the poison arising from this privy well.

Various circumstances have turned my attention toward prophylaxis, and toward avoiding rather than antagonizing these agents. In 1884 I visited some of the hospitals of Europe, and had this subject in mind. On going to Hamburg, I found, in connection with the female department of the general hospital of that city, a new room just built, which had four outside walls. About six feet of open air had to be passed to get into it. It was thought that the atmosphere from the inhabited part of the building might not be a good thing. I have carried on the study which I introduced at the last meeting with reference to procuring something better than the outside air. I wish now to make a further presentation of the subject. I may say that I have not succeeded in getting all the organisms out of the air. Those which seem most abundant and get through, are the spores of mould. These seem to be the lightest in the whole series, and delight in rising against moisture.

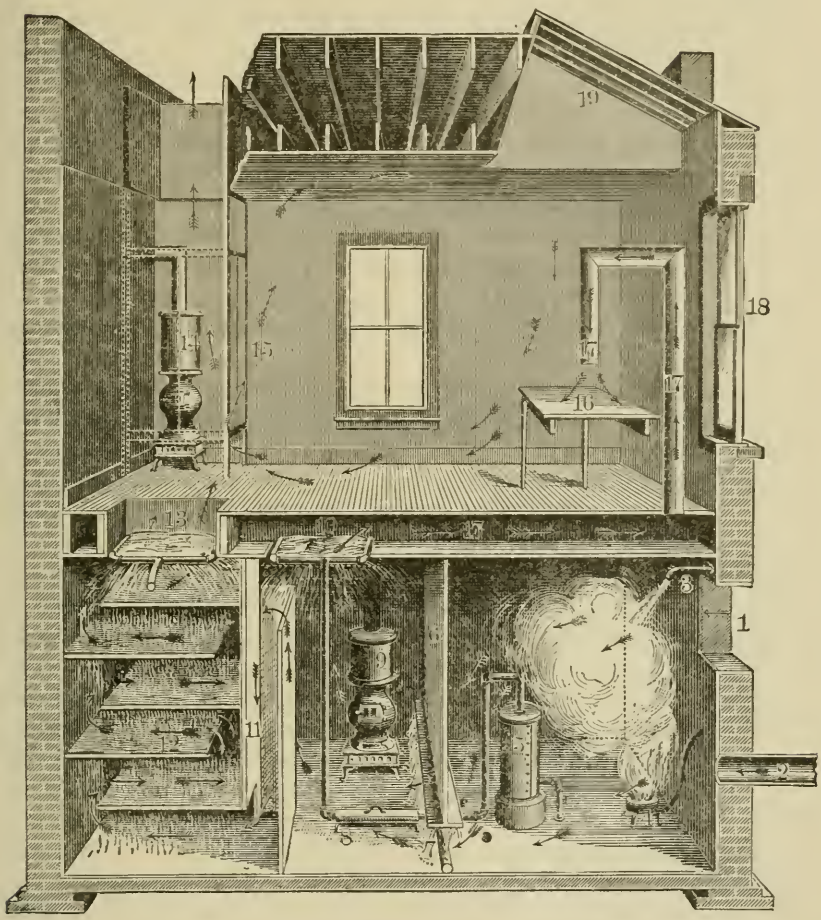
The device which I have worked out is in two parts, or with two purposes: one supplies the general atmosphere of the apartment; the other, the atmosphere by which the portion of the patient which is the seat of operation is surrounded. I have here a diagram illustrating the arrangement.

The other day, in New York, I saw Dr. Charles C. Lee make a laparotomy. The operation was done in a little building with two rooms. It was a windy day and the dust was flying. The windows were shut and it was very oppressive. Dr. Lee worked away in the most skilful way, the sweat from his face dropping into the abdomen. I said afterward to the gentleman who was assisting him (Dr. Hanks) that it would be a nice thing if we could have a comfortable atmosphere for the operator, and a moist and warm atmosphere for the patient, and showed him this diagram. It is feasible to have a comfortable temperature in the room, while the temperature around the wound may be anything that is desired. A thermometer is connected with the tube so that the temperature of the air may be observed.

In the plan as presented last year, there was no special provision for securing for the wound an atmosphere any more pure than that of the room in general. In the plan now presented, there is a plan for blowing upon the portion of the body which is the seat of an operation, a volume of air which has undergone a special purification, and

which must carry away from a wound any floating material which may have been set free from the bodies of the people in the room, and which might otherwise fall into it.

The water which serves for the washing of the portion of the air



falling upon the wound is supposed to have been treated with mercuric bichloride in the tank (5), and to have been acidulated with sulphurous acid from the burning of sulphur (4). The details are so well delineated in the cut as to explain themselves.

1. Entrance of air from the outside in cool or cold weather.
2. Entrance of air forced in by a fan run by an engine in hot weather.
3. A steam jet for thoroughly washing the air and its floating contents.
4. Sulphur pot.
5. Reservoir for sublimated water to supply the spray (10).
6. A screen, reaching from the ceiling to within eighteen inches of the floor.
7. A spray playing under the base of the screen, and through which the air in its movement must pass.
8. An arrangement for heating, by the flame of gas or alcohol, the water as it flows, which supplies the spray (10), in order that the air may be warmed by the water in passing through it.
9. A stove employed in cool or cold weather to warm the air passing the spray (13), and supplying the room above with pure and warm air.
10. Spray for the special purification of the air passing through the pipe (17).
11. Another screen, under the bottom of which the air must pass after having passed over the top of the associated screen, as shown by the arrows.
12. Shelves of thin muslin, through which the shower from the spray (13) drips, the arrows showing the course of the air through the shower.
13. Spray in the entrance of air to the room above.
14. A stove for heating the air on its exit from the room.
15. A screen obliging the escaping air to come from the floor.
16. Section of an operating table.
17, 17. The course of the air specially washed for surrounding the portion of the body under operation and excluding any other air, and driving away the particles that may escape from the occupants of the room.
18. Section of a window for horizontal light.
19. Section of a skylight.

The arrows show everywhere the course of the currents of air.

It is not supposed that, by the arrangement here shown, absolute rest has been secured.

The task especially necessary to be done is to remove those agents which start putrefactive and erysipelatous changes.

The spores of various species of mould have the greatest tendency to rise in dampness—being the lightest, and they are therefore the most

likely to escape the traps here placed for them; but it fortunately happens that they are the least injurious.

The plan is too new for a full proof of its merits. The room described has been in use a year and a half for surgical purposes, and no case of putrefaction or erysipelatous complication has arisen soon enough after an operation to be attributed to any influence initiated at the time of the operation.

Another year in the use of the room and in the study of the subject may result in a more mature estimate.

In the treatment of the sick the suggestions of this plan may be found valuable, helping to devise methods of furnishing, in economical ways, pure air in place of that which is contaminated by the occupants of a room.

The device is given to the public as a contribution toward greater success in surgery, through the exclusion of an invisible enemy, which until recently has not even been conceived of as the cause of putrefactive changes in animals.

It is a contribution toward the securing of such an atmospheric condition as may permit the opening of any portion of the body and closing it up again; and yet having the wound in such a condition as to freedom from the causes of septic and erysipelatous complications, as if the opening had been made subcutaneously.

I offer the following translation and condensation, in order to secure a more full presentation of the subject:

"In the *Revue de Chirurgie* for February, 1884, p. 145, Ogston is quoted (from "Report upon New Organisms in Surgical Disease," *British Medical Journal*, for March, 1881, p. 369) as having examined the contents of 88 unopened abscesses. Of these, 74 were acute abscesses; and under examination by staining with aniline colors, after Koch's method, with an objective immersed in oil, there was the constant exhibition of micrococci. In the 14 cold abscesses (osseous, caseous, and scrofulous) microbes were not always found.

The subject is discussed by Pasteur in a contribution to the Academie de Médecine, April 30, 1878, upon the theory of germs applicable to medicine and surgery.

Uskoff (Virchow's *Archiv*, 1881, vol. lxxxvi. p. 150) asks, Can there exist suppuration without the intervention of inferior organisms? He injected under the skin of dogs, distilled water, olive oil, milk, and oil of turpentine. The places of injection were previously dis-

infected. The injection of turpentine always produced suppuration without the presence of micrococci. His conclusion was, that "suppuration can occur without the presence and intervention of any inferior organism."

Orthmann, under the direction of Kasenbach ("Ueber des Ursachen der Eiterbilding," Virchow's *Archiv*, 1883, vol. xc. p. 540), always secured suppuration by the injection of turpentine, but he could not find in the pus so produced any microbes. The investigation was conducted by the aid of staining by methyl-violet and by gelatine culture. The experience was the same with subcutaneous injection of mercury.

Councilman ("Zur Etiologie der Eiterung," Virchow's *Archiv*, 1883, vol. xcii. p. 217). The skin of the back of rabbits, guinea-pigs, and rats, was first shaved and then slightly burned with Paquelin's cautery. For the insertion of liquids a syringe was employed having a glass point, drawn out just before using; while behind the liquid to be injected was sterilized cotton. The mouth placed upon the tube caused the liquid to be pushed into the tissue by the pressure of air filtered through this cotton. On withdrawing the glass point the thermocautery was again lightly placed upon the surface.

For the introduction of solid bodies, a small metallic trocar and canula, first heated in a flame, was introduced, the trocar withdrawn, and in its place was introduced a small metallic repositor—a tube smaller than the canula having inside of it a piston to follow the solid body, all sterilized by flame before introduction. These are the results:

Eighteen injections of 2 cubic centimetres of turpentine, the animals being killed in from three to twenty days. In 13 cases there was no suppuration. In some cases there was complete resolution, except a slight ecchymosis of the subcutaneous cellular tissue; more often there was a liquid with the odor of turpentine. On microscopic examination the liquid was found to be an emulsion of turpentine containing leucocytes. In 5 cases yellow pus was found with an odor of turpentine, and containing micrococci in great numbers. These microbes were reproduced by various modes of culture.

Five injections were made of a ½ c. cm. of a mixture of olive oil and Croton oil. In four cases there was no suppuration; in the fifth case there was pus, with the presence of micrococcus.

Two guinea pigs were injected each with 10 grains of mercury, without suppuration.

In the subcutaneous introduction of sterilized fragments of cloth, elder-pith, cork, and phosphorus, there was never any suppuration. The foreign bodies became encysted by a very fine transparent membrane. The sections of the elder-pith were particularly instructive. The polygoneal elder-pith tissue was full of leucocytes, more abundant at the periphery than at the centre. The fragments of phosphorus produced no suppuration.

The experiments just related show, contrary to the conclusions of my predecessors, that substances considered as irritants, as turpentine and croton oil, are not sufficient of themselves to produce suppuration. These bodies can be *phlogogenes*, but not pyogenes; for true suppuration the intervention of inferior organisms is necessary.

Cornil ("Note sur l'anatomie du phlegmon et en particulier sur le siege des bacteries et sur le mode de propagation," *Bul. de la Soc. de Méd.*, 1883, p. 673) studied the anatomical lesions of fragments of living skin removed in connection with the opening of abscesses. The fragments were immediately placed in strong alcohol, and the sections of them were stained with various aniline colors. In the subdermic connective tissue most affected by inflammation there were lesions in the contents of the vessels in the fixed cells, in the fascicles of the connective tissue, and in the migratory cellules. A partial destruction of the invaded tissue of the exudate was more or less advanced.

In the blood contained in the vessels, in the exudated liquid, in the migratory cells, and in the fixed cells of the connective tissue, were found a great quantity of micrococci united two by two, or disposed in minute chains.

In the portions of connective tissue less influenced, the small veins often contained a coagulation of fibrin, showing diplococci or chains of these elements, and the lymphatic cells scattered through the fibrinous coagulate contained the same bacteria.

Examining the pus discharged from abscesses, he always found a great quantity of micrococcus of chains.

Dr. ERNST. I have only a few words to say in conclusion. In the first place, in regard to the criticism of the last speaker that there was suspicion that the bacteria found in the cultures might have gained entrance in the manipulations. This is answered by the fact that careful control-inoculations were always made. In all the cases reported, I inoculated from eight to twenty tubes from the purulent material, and at the same time inoculated other tubes with needles

not passed into the pus. Micrococci invariably appeared in the tubes inoculated from the pus, while the sterilized tubes presented no change. This was so a matter of course that I did not consider it necessary to speak of it.

In regard to Dr. Billings's criticism of the syringe, I feel that I must take exception. It seems to me the best form yet devised. The bulb may be removed, and the valve regulates the amount of material injected. The same syringeful may be used with different needles for a number of animals. With the Sternberg tubes, you must measure the material exactly before introducing it. They are not so convenient as the syringe. I have tried the Sternberg bulbs, but it seems that in practice this was the more complete. The bulb is kept in corrosive sublimate solution, and is in addition sterilized by steam heat, and the other parts may be subjected to any amount of heat desired.

THE SURGERY OF THE PANCREAS,

As Based Upon Experiments and Clinical Researches.

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In the following article, an attempt will be made to lay the foundations for a rational method of treatment of some of the injuries and diseases of the pancreas by direct surgical measures. The literature on the surgery of the pancreas is exceedingly scanty and loosely scattered through the medical journals and text-books, as no previous attempt has been made to arrange the material in a systematic form for ready reference. Our present knowledge of the surgical treatment of diseases of the pancreas is limited to a few operations performed for the cure of retention cysts, by excision or the formation of an external pancreatic fistula. The clinical material which I have collected, and more particularly the description of pathological conditions found within and around the pancreas at post-mortem examinations, will be utilized for the purpose of pointing out new indications for operative interference, by such methods as will suggest themselves from the results obtained by experiments upon animals.

I. Comparative Anatomy of the Pancreas.

A few words on the comparative anatomy of the pancreas are necessary in order to compare the results obtained by certain experiments with similar conditions when observed in the human

subject as the result of traumatism or pathological changes. In some of the higher invertebrates certain organs connected with the alimentary canal have received the name of pancreas; but they have done so rather from their position and inferred function than from any certain evidence of their use, or from their anatomical structure.[1] If they exist, they consist of simple cæcal appendages attached to the upper part of the intestine.

In the osseous fishes, certain cæca or blind tubes may be seen at the commencement of the intestinal canal, close to the pylorus, which from their position have received the name of pyloric appendages, and have been regarded by most anatomists as the analogue of the pancreas in higher animals. In reptiles, we make a greater approach to the structure of the pancreas of higher animals, both in form and structure. In the frog the pancreas is shaped not unlike that of the human subject, but its broad end is in the opposite direction. It is in close approximation with the duodenum in its whole length. A proper duct cannot be found; probably small ducts from different parts of the gland open into the biliary duct as it passes through the gland. The pancreas of birds is proportionately larger than in any other animal. The gland has always more than one, usually two or three ducts which open by separate orifices and often at some considerable distance from one another.

The chief differences between the pancreas in other mammalia and man relate merely to its color, its consistence, its degree of lobulation, its form, its volume, its union into a single mass or its separation into two distinct parts, and, lastly, its position and relations with different portions of the peritoneum.

Its form is generally more or less that of a narrow band, divisible into two portions: one, the duodenal, following the curvature of the duodenum, and placed vertically or obliquely; the other, the gastrosplenic, extending transversely, and therefore opposite the other, from the duodenum to the spleen, against which it rests; the latter is always developed, the former is often defective or absent, and must be considered merely as an accessory portion.

[1] Cyclopedia of Anatomy and Surgery, vol. v. p. 90.

In the carnivora the pancreas is always large in proportion to the size of the animal. In the ox, from the distinctness of the two portions, the organ has a bilobar appearance. In the horse, from the gastrosplenic portion being doubled, it has a trilobar form. In the rodents, the organ is spread out in an arborescent manner, in an extensive mesentery that imparts free movement to the long duodenum, and extends to the left in a sort of omentum which underlies the stomach. In the rabbit, the duct enters the intestine nine inches or a foot from the pylorus. In the mammalia, as in man, there is usually but one pancreatic duct, which enters the intestine near the pylorus, although sometimes a great way removed from it. There are, however, considerable varieties of insertion. In the lion, two pancreatic ducts join the common bile-duct separately, one near the other. In the dog, I have made the observation that the ducts from both portions of the pancreas unite near the duodenum or within its wall, and that the orifice of the common pancreatic duct is usually located about an inch or two below the opening of the bile-duct. If an accessory duct exists, it usually opens into the intestine at a point in common with the bile-duct.

Berard and Colin (Canstatt's *Jahresbericht*, 1857, 1–3, p. 64) have shown that the pancreas is not connected with the duodenum in young dogs. It consists originally of two parts, of which one lies parallel to the duodenum (caudex inferior), and the other perpendicular (caudex superior). These two portions join later to form a mass which becomes adherent to the duodenum. Each portion has its own duct, which afterward join to enter the intestine about two and a half centimetres below the opening of the bile-duct. Sometimes there is a second duct arising from either portion, or more rarely from both, which enters the duodenum by the side of the bile-duct.

The pancreas of the pig has usually only one duct, but when two exist, the second smaller duct communicates with the principal duct which opens into the common bile-duct.

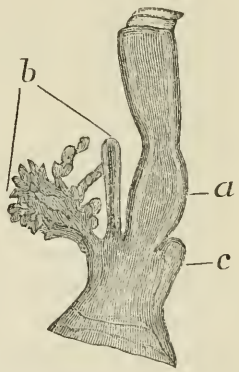
The irregular distribution and insertion of the pancreatic duct in mammalia and the frequency with which a second and third duct is found, are important to remember in connection with ex-

periments on the pancreas, by intercepting the secretion by ligation of the duct, as it is exceedingly difficult if not impossible to ascertain the existence or absence of the small accessory ducts, and on this account it would be impossible to prove that all of the outlets of the gland had been intercepted, even if more than one duct had been found and ligated.

II. Development of the Pancreas.

Remak has studied the development of the pancreas in the young chick ("Entwickelung der Wirbelthiere," Berlin, 1855, pp. 54, 115, 164). He found that the matrix could be seen somewhat later than that of the liver—about sixty-five hours after incubation had commenced. It consists primarily of a bulging

Fig. 1.



Embryo of Chick, Four Days Old.

a. Stomach.
b. Liver and bile-ducts.
c. Pancreas.

of the hypoblast of the posterior wall of the intestinal tube, covered by a thickened prolongation of the connective tissue layer of the bowel. (Fig. 1.)

The embryonal pancreas shows in the beginning a cavity which is in communication with the open lumen of the bowel. The changes which take place in the embryonal pancreas during

the first five days can be readily observed and are easily understood.

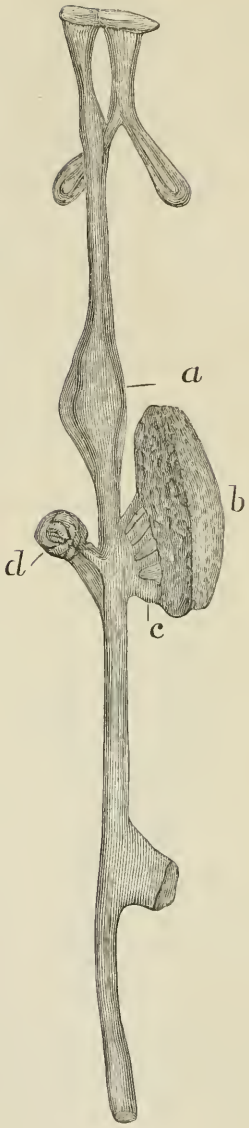
From the thick wall of the hypoblast, numerous small, solid lobules spring, while the hollow space in communication with the bowel assumes more and more the shape of a canal. The connective tissue layer does not increase in size in the same degree, and presents no lobular projections upon its surface. On this account the new organ has assumed a pyriform shape externally; on the other hand, the glandular portion in the connective tissue layer takes on a branched structure. (Fig. 2.)

The hypoblastic layer is the basis of the parenchyma. Composed of cells, the connective tissue layer serves as the basis for the vascular constituents of the gland. The embryonal connective tissue disappears during the development of the gland in proportion as the cellular portion increases, until, finally, only enough connective tissue is left to serve as a nidus for the vessels and as a membrana propria of the acini.

The pancreas is not developed by symmetrical folding of both walls of the intestinal canal, but each wall grows by proliferation in different degrees to form the pancreas. The excavation in the rudimentary gland does not exist at first, but the original and essential structures are the cellular parenchyma of the gland from the epithelial lining of the intestine, and the vessel- and nerve-enveloping layer of connective tissue. As the pancreas in birds has two ducts, the question arose how the second duct is formed. The most plausible explanation was afforded by the assumption that the primary duct divides itself into two in a longitudinal direction. Remak, in 1846, found another explanation by examining two geese, between three and four weeks old. He found two ducts at a short distance from each other in connection with the wall of the intestine. A closer examination showed, however, that only one of the ducts, the upper, was in communication with the lumen of the intestine; the other presented a blind pouch adherent to the wall of the intestine.

From this, it may be concluded that the second duct springs from the first, and, at a later period, a new communication with

FIG. 2.



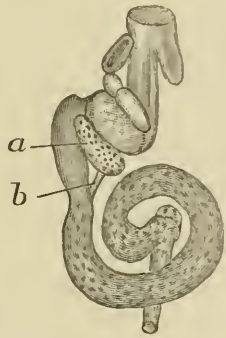
EMBRYO OF CHICK, FIVE DAYS OLD.

a. Stomach.
b. Liver and bile-duct.
c. Gall-bladder.
d. Pancreas.

the bowel is established at a point corresponding to its cæcal extremity.

He has since observed the same condition in the larvæ of frogs. (Fig. 3.) It appears then established that the first and

FIG. 3.



LARVA OF FROG.

a. Pancreas.

b. Pancreatic duct.

primary duct of the pancreas is found in the rudimentary organ, and is from the beginning in communication with the bowel, while any additional ducts, whether normal or anomalous, originate in the substance of the gland and only secondarily are brought in communication with the bowel by a process of atrophy and absorption between the cæcal extremity of the duct and the intestinal wall. The existence of anomalous ducts communicating with one of the principal ducts and the intestine can be explained in a similar manner. Thus, in dogs it is uncommon to find a small duct in the gastrosplenic half of the gland, connecting the intestine at a point where the common bile-duct opens into the intestine, with the common duct as illustrated by specimen No. 28.

It is apparent that in cases of this kind obliteration of the common duct on the distal side of the anomalous or accessory duct would not interfere with the normal evacuation of the secretion into the intestinal canal. The occurrence of an acces-

sory pancreas can only be explained by the assumption that during the growth of the rudimentary pancreas, certain portions of the secreting structure become isolated by constriction and displacement, and that such portions of the gland are brought into communication with the intestinal canal by the development of an accessory duct.

III. Physiology of the Pancreas.

A brief consideration of the most important functions of the pancreas becomes necessary in connection with our subject, as it will serve to furnish an interpretation of some of the symptoms observed in such affections of the pancreas as interfere with the normal secretion or outflow of the pancreatic juice.

Claude Bernard, in 1848, discovered the most important function of the pancreatic juice, by observing that it exerted an emulsifying effect upon all kinds of fat. He found that by mixing fresh pancreatic juice with oil, lard, butter, or tallow, and keeping the mixture at a temperature of 35° to 40° C., an emulsion is formed almost immediately. (Schleiden and Froriep's *Neue Notizen*, vol. vii., No. 136, pp. 55, 56.) Saliva, gastric juice, bile, and blood-serum do not produce this effect. The emulsifying process takes place by the division of fat into minute globules by the pancreatic juice without converting it into a new chemical compound. The organic principle in the juice which possesses this property is very easily decomposed and precipitated by heat. Bile, with pancreatic juice, dissolves neutral as well as acid fats. Bernard ligated both pancreatic ducts in dogs, and the single duct in rabbits, and fed the animals on fat. The fat was found unchanged in the intestinal canal and the lacteals were empty. Fatty diarrhœa has been observed in a number of cases where the pancreas was the seat of extensive lesions, and the presence of this symptom should always lead the physician to make special search for additional symptoms confirming the suspicion of the existence of disease of the pancreas.

There is no dispute among physiologists in regard to the

action of pancreatic juice in transforming starch into sugar. This function was first observed by Valentin, in 1844, who experimented with an artificial fluid made by infusing pieces of pancreas in water. Bouchardat and Sankras first observed this property in the normal pancreatic secretion. The property of converting starch into sugar is possessed also by the saliva and intestinal juice; it therefore becomes an important question to determine the effect of a defective pancreatic secretion in cases where there is imperfect digestion of starchy food. It seems that cane sugar is transformed into glucose almost exclusively by the action of the pancreatic juice. This fact has received confirmation in the case of intestinal fistula observed by Busch. The fistula was located in the lower portion of the small intestine. When cane sugar was introduced in quantity into the stomach, fasting, the fluid which escaped from the upper end of the intestine contained a small quantity of glucose, but never any cane sugar. Cane sugar introduced into the fistula so that it would pass along only the lower end of the bowel, was not converted into glucose, but a large portion of it was found in the feces as cane sugar. In cases of suspected organic lesions of the pancreas it would, therefore, appear advisable to resort to feeding with cane sugar and subsequent examination of the stools for undigested cane sugar as a diagnostic measure. The presence of cane sugar in the stools would indicate that little or no pancreatic juice is secreted.

The last function of the pancreas consists in converting, with the aid of the bile and intestinal juice, the albuminoids, such as gluten, fibrin, albumen, casein, and musculine into albuminose or peptones. This latter effect of the pancreas has been doubted by a number of German physiologists, but the fact seems to be demonstrated by experiment as well as by the circumstance that the pancreas is larger in carnivorous than in herbivorous animals.

Schiff has found that the physiological function of the pancreas is at its maximum about nine hours after the ingestion of food, and at its minimum about four to six hours later. During the greatest activity of the gland the vessels become more

turgid, and can be seen with the aid of a lens between and upon the lobules, while during a state of rest they are seen only between the lobules. During digestion the gland presents a pale red color, while during rest it appears grayish-white.

The influence of the nerve-centres upon the pancreas has been made a subject of careful study by Schiff (Canstatt's *Jahresbericht*, 1861, 1–3, p. 119). Section of both pneumogastric nerves has no effect upon the circulation or secretion of the pancreas. Animals subjected to this experiment readily digested dextrine or peptones introduced into the stomach; but if ordinary food was given, no secretion took place, as stomach digestion was suspended. Total destruction of the three semilunar ganglia of the sympathetic arrests completely the secretory functions of the pancreas, even if the most favorable conditions are established by the introduction of food or injection of the products of digestion into the stomach. Wounding of these ganglia short of total destruction does not produce the same effect. Injury of the spinal cord, on a level with the eighth, ninth, or tenth rib, does not interfere in the least with stomach digestion, but promptly arrests all secretion from the pancreas, which can not be excited by food nor by the presence of dextrine in the stomach. Heidenhain has ascertained that stimulation of the medulla oblongata increases the flow of pancreatic juice as well as its active constituents. These experiments show that the reflex action of the stomach upon the pancreas is not transmitted through the sympathetic, but through the spinal cord. That the essential active principle of the pancreatic juice is necessary for digestion, has been shown by Corvisart, who found that in dogs the pancreatic juice contained, nine and a half hours after a meal, no ferment which was capable of dissolving albuminous substances. If, however, the animal was made to fast for a longer time than this, the ferment was again produced in some unknown manner. Pancreatic digestion becomes apparent six or seven hours after a meal, the time being somewhat dependent upon the duration of digestion.

The present views concerning the action of the pancreatic juice in the process of digestion may be summarized as follows:

1. Starch is converted by a diastatic ferment into dextrine and sugar, a continuation of the action of the saliva in the intestine. 2. Melted and fluid fats are emulsified by it (a property which has been assigned in a less degree to bile); at the same time, glycerine and fatty acids are formed during the process. The emulsifying process is aided by the fatty acids and alkaline salts which effect saponification (Brücke, Gad, Quincke). 3. Albuminoid substances and glue-containing tissues when mixed with an alkaline solution are dissolved and converted into peptones independently of stomach digestion (Corvisart). A portion of the peptones undergoes still further changes: as in the case of albuminoid substances, leucin, tyrosin, xanthin, and sarcin; in the case of glue, tyrosin, glycin, and ammonium may appear.

Fresh pancreatic juice obtained from the duct of Wirsung is a clear, viscid, alkaline, highly putrescible fluid, of a specific gravity of 1.030, which solidifies completely on boiling. Pancreatic juice contains: 1, albumen; 2, a number of ferments, 3, salts, especially of soda; 4, water; sometimes traces of self-digestion of the juice can be found, especially leucin (Hermann). (*Lehrbuch der Physiologie*, Berlin, 1882, p. 107.)

The pancreas secretes continually in herbivorous animals; in carnivorous, only during digestion (Heidenhain). The ferments are always present in the gland, trypsin only in a state of preparation, a so-called zymogen, which, on division, yields trypsin; this division takes place on exposure of the gland to air, the action of oxygen, very dilute alkalies, acids, alcohol, etc. During secretion the cells of the lobules are enlarged while the latter become swollen; at the same time the vessels are considerably dilated. The exact quantity of pancreatic juice secreted in man and most animals is unknown. From a practical point of view, it is important to allude to the effect of the pancreatic juice upon the skin, which it macerates, so that when the fluid remains in contact with the skin for any length of time it becomes irritated and presents a raw, eczematous surface. It also appears that the same effect is not produced when it is brought in contact with the peritoneum, because in this locality fresh pancreatic juice is removed rapidly by absorption. A positive diagnosis of dis-

ease of the pancreas will only become possible when more attention shall be bestowed upon the symptoms arising from defective digestion, the result of a defective or faulty function of the pancreas—a pancreatic indigestion. Long-continued indigestion of fatty or starchy food should be considered a sufficient indication for instituting a most careful search for pancreatic disease, by ascertaining the effect upon digestion of particular articles of diet and by examining with care the discharges from the bowels.

IV. Experiments on the Pancreas.

The operative treatment of injuries and diseases of the pancreas belongs to the future. Until now, the efforts of surgeons have been limited to the treatment of a few cases of cysts of the pancreas. The results obtained in these cases have been so encouraging, that undoubtedly other lesions of this organ will soon constitute new indications for surgical treatment.

The clinical material that is now available is inadequate to furnish a reliable basis for new operations; on this account it has been my object to obtain new light by subjecting the pancreas to a variety of surgical procedures, to ascertain the tolerance of this organ to direct treatment, and to determine, if possible, how much of the gland could be removed with safety in case it is the seat of injury or disease. The object of these experiments also included an attempt to elucidate some of the causes and pathological conditions of some of the well-recognized lesions of this organ.

Dogs and cats were used exclusively as objects of these experiments, as a few trials soon satisfied me that in the smaller herbivora, as the rabbit and sheep, the pancreas was proportionately small and difficult of access. The operation was always performed under antiseptic precautions, with the exclusion of the spray, and the typical orthodox dressing. The abdomen was always shaved and disinfected with a solution of corrosive sublimate, ether was used as an anæsthetic. The abdominal incision was made through the linea alba, from near the tip of the xiphoid cartilage to the umbilicus.

The omentum major was either pushed upward, or, in the majority of cases, an opening was made into it by tearing at a point opposite the external incision. The guide to the pancreas was always the pyloric orifice of the stomach—after the index finger had reached this point, it was passed along the duodenum for three or four inches, when the bowel was grasped between the index finger and thumb and brought into the incision with the pancreas. If any considerable prolapse of the viscera was made necessary to accomplish the object for which the operation was made, the exposed organs were carefully protected with a compress of gauze wrung out in a warm weak solution of corrosive sublimate (1 : 2000). Irrigation of the external wound and protruded organs was frequently resorted to with the same solution, to cleanse the parts of blood, and to preserve the wound in an aseptic condition. A good light and an empty stomach facilitated the operation greatly.

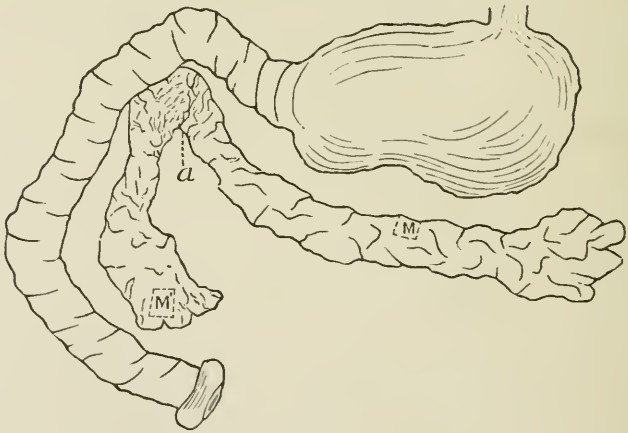
It was always found difficult to detach the pancreas from the duodenum without incurring a considerable and often dangerous loss of blood. To prevent this occurrence most effectively, blunt dissection and direct compression with a moist, hot, aseptic sponge, proved the most effective measures; when large vessels were to be divided double prophylactic ligation was often resorted to. After completion of the operation the pancreas and duodenum were thoroughly cleansed and dried, and the toilet of the peritoneal cavity made with care; the abdominal incision was closed with interrupted sutures introduced in the usual manner so as to include the peritoneum. The external wound was sealed with a small compress of iodoform cotton repeatedly saturated with iodoform collodium. At the end of a week the sutures were removed. Primary union of the abdominal incision was the rule, in only a few instances was healing of the wound accomplished by granulation. Ventral hernia was observed in a number of cases.

Complete Section of the Pancreas.

Complete section of the pancreas was made an object of experimentation, to ascertain whether the continuity of the pancreatic duct would be restored after complete division and subsequent accurate coaptation, and to study the process of repair between the divided ends of the pancreas. The section was made transversely, and, after arresting all hemorrhage, the margins of the wound were brought into accurate contact with deep catgut sutures, which were made to embrace the entire thickness of the organ.

Experiment I.—Dog, four and a half months old; weight, 35 pounds. Operation performed August 23, 1885. Complete division of pancreas transversely through the middle portion; vessels ligated with fine catgut, the hemorrhage being arterial from the gastrosplenic,

Fig. 4.



a. Point of section and coaptation by sutures.

Sections from M, gastrosplenic portion, show parenchyma cells in a state of fatty degeneration. Connective tissue increased.

Sections from M', duodenal portion, show normal structure. At *a*, narrow band of cicatricial tissue.

and venous from the duodenal end. Cut surfaces brought together accurately with fine catgut sutures, which were passed through the entire thickness of the organ, about one-third of an inch from the

margins of the visceral wound. Animal showed no signs of suffering or disease after the operation, but lost four pounds in weight during the first eight days. After this time the animal began to increase in weight. Highest temperature 104° F., on the fourth day. Animal killed December 6, 1885, 105 days after the operation.

An examination of the pancreas showed that union had taken place between the two ends by means of a narrow cicatrix, which was indicated by a slight constriction at the site of section. Duodenal portion of gland presented a normal appearance, as the section had been made on the splenic side of the common duct. Gastrosplenic end somewhat atrophic and sclerosed. Pancreatic duct patent to cicatrix, where the principal duct of the splenic portion was completely obliterated. No dilatation of duct in the splenic end. (Fig. 4.)

Experiment II.—Adult dog, medium size; complete section of pancreas through the junction of the middle with the splenic end. Only artery from splenic end required ligation. Immediate coaptation by means of three catgut ligatures passed through substance of gland. Animal remained well after the operation; appetite unimpaired. Dog was killed three weeks after the operation; abdominal wound completely healed; at point of section slight adhesions to neighboring organs. Visceral wound healed by a linear cicatrix of young connective tissue. Pancreatic duct completely obliterated at site of operation.

Remarks.—These operations would tend to show that complete division of the pancreas, if not complicated by other and more serious lesions, is not a dangerous accident, if the only source of danger, hemorrhage, is met by proper surgical treatment. The coaptation of the divided ends would be desirable, but is not essential, as the continuity of the duct is not restored after this injury. No disturbance of digestion was observed in either case, as an adequate amount of pancreatic juice was secreted from the portion of the gland which remained in communication with the lumen of the intestine. As in both of these instances a greater or less amount of pancreatic juice must have escaped into the peritoneal cavity from the cut surfaces, and perhaps later from the divided duct of the splenic end, we have thus early evidence of the innocuity of extravasation of pancreatic juice into the peritoneal cavity. The process of repair

was in both instances accomplished by the interposition between the divided and coaptated ends of a linear cicatrix.

Although accurate approximation was effected by three sutures, transfixing the entire thickness of the gland by passing the needle from before backward on one side, and from behind forward on the other, it seems that primary union between the divided ends failed to take place, and that the process of repair was accomplished by connective tissue proliferation, from the connective tissue on the surface of the wound, a process necessarily accompanied by a simultaneous degeneration of the parenchyma of the gland, over an area corresponding to the seat of cicatrization.

Microscopical examination of the sections made in close proximity to the cicatrix, showed various degrees of degenerative changes in the cells of the parenchyma, with a corresponding space of connective tissue proliferation.

Complete section of the duct, even when the ends are kept in accurate coaptation, appears to result uniformly in the obliteration of the duct at the site of section. The obliteration is the direct result of the formation of a cicatrix in the lumen of the duct from the cut surfaces. In both specimens the length of the cicatrix, consequently the extent of impermeability of the duct, corresponds to the length of the cicatrix interposed between the divided ends of the gland.

The practical deductions to be obtained from these experiments are: that in transverse visceral wounds of the pancreas, the most important indication that presents itself, is to arrest hemorrhage by ligating the bleeding vessels, and to resort to suturing of the severed organ with a view to retain both ends of the pancreas as nearly as possible in their normal location, and thus maintain as nearly as possible the integrity of the vascular supply, rather than with a purpose to obtain restoration of continuity of the divided pancreatic duct, which, if it could be accomplished, would preserve the physiological importance of the detached portion of the gland. By the detached portion of the gland, I mean that portion which no longer remains in physiological connection with the intestine,

and which never regains its physiological importance after the duct has become obliterated by a cicatrix at the point of section.

Laceration of the Pancreas.

Having observed that complete section of the pancreas is followed by severe hemorrhage, both arterial and venous, which undoubtedly might prove a source of no inconsiderable danger in cases of similar wounds of the organ in man, the following experiment was made to ascertain the extent of hemorrhage after laceration of this organ, without the intervention of treatment.

EXPERIMENT III.—Large adult cat; weight, 7½ pounds. Abdomen opened through the median line, the pancreas exposed and detached sufficiently from the duodenum at the junction of the middle with the duodenal end, where it was torn completely across and the bleeding ends dropped into the abdominal cavity; the wound was closed in the usual manner.

The hemorrhage was noticed to be much less than after section. Highest temperature 104.6° F., two days after operation. No symptoms of hemorrhage or peritonitis. Oct. 11, sutures were removed, the abdominal incision having apparently closed. Oct. 17, the wound opened, and it was reported that one end of the pancreas had protruded from the wound. The prolapsed viscus and wound were disinfected, the organ replaced, and the opening closed with sutures.

The animal did not appear to be very ill, but died two days later. At the autopsy no effusion was found in the peritoneal cavity and no signs of general peritonitis. A portion of the duodenum appeared gangrenous. The lacerated end of the splenic portion was adherent to the duodenum at a point two inches below the pyloric orifice of the stomach. The duodenal portion was very much atrophied and drawn up toward the splenic portion, and united to it by an extensive mass of cicatricial tissue. On opening the pancreatic duct from the duodenum, no communication could be found between it and the gastrosplenic portion of the gland.

Death in this case resulted in the accidental reopening of the abdominal wound. The prolapsed organ was, in all probability,

the duodenum and not the pancreas; the gangrene of the intestine undoubtedly was caused by the prolapse and strangulation before the bowel was replaced. The laceration of the pancreas was made at a point where the two ducts meet; hence the impermeability of the duct in the gastrosplenic portion of the pancreas. Hemorrhage was arrested spontaneously, and the process of repair, so far as the wound in the pancreas was concerned, appeared to be satisfactory. The divided ends were displaced considerably immediately after the laceration, but were subsequently brought into close contact by the cicatricial contraction.

Comminution of the Pancreas.

It has been asserted by a number of authorities that dead pancreatic tissue is a highly putrescible substance, and on this account its presence is very liable to serve as a source of infection.

Believing that putrefaction can never occur without the specific germs, even in the case of dead and highly putrescible substances, the following experiments were made to test the correctness of this assertion:

Experiment IV.—Maltese cat; weight, 3¼ pounds. Operation September 18, 1885. The pancreas, with its vessels, was completely detached from the duodenum to the extent of two inches, about the middle of the gland. The isolated portion was completely crushed between the blades of a sequestrum forceps. No hemorrhage whatever occurred, and the organ was dropped into the abdominal cavity. The day after the operation the temperature rose to 105° F., but the next day it was normal, and remained so until the killing of the animal, December 13, eighty-six days after the operation. No evidences of diffuse peritonitis, only slight adhesions where the gland had been crushed. The duodenal portion was atrophied and drawn toward the gastrosplenic portion, to which it was united by a firm cicatrix, which united the two ends of the gland to the duodenum, thus completing the mesenteric attachment of the bowel. The cicatrix *a*, showed a line of pigmentation throughout its entire thickness. (Fig. 5.) The crushed portion of the gland had disappeared entirely by absorption,

and its place was occupied by a firm cicatrix, which, by contraction, had approximated both portions of the gland. The crushing was done below the point of entrance of the pancreatic duct, which caused the atrophy of the duodenal portion, which was no longer in physiological connection with the duodenum.

FIG. 5.

a. Point where gland was crushed.

Sections from M show normal tissue.

Sections from M' show fatty degeneration and sclerosis.

EXPERIMENT V.—Young cat; weight, 2½ pounds. Pancreas brought into the abdominal incision, with a loop of the duodenum, and without separating it from the bowel it was crushed at its middle to the extent of two inches between the blades of a sequestrum forceps. No hemorrhage followed the procedure, and the organ was dropped back into the abdominal cavity. The animal had been in bad condition before the operation, and died seven days later. At the autopsy the abdominal incision was found closed. No peritonitis or effusion. Crushed portion showed no signs of suppuration, but appeared thicker and shorter than after the crushing, a change which was attributed to the infiltration of the dead tissue by leucocytes and connective tissue proliferation. The two ends of the gland were brought into closer

contact by contraction of the recent cicatrix, which had also the effect of doubling the duodenum upon itself.

Remarks.—In both instances the crushed parenchyma of the organ was promptly removed by absorption, which seems, in this particular locality, to proceed with unusual activity, an occurrence which can only be explained by the assumption that the peritoneum is active in this process. No infection took place, and no evidence of putrefaction could be found. Should wound infection take place in cases of this kind, there can be no doubt that the dead pancreatic tissue would serve as a most favorable soil for the septic germs, and would thus create the most essential condition for rapid and most dangerous form of infection.

These experiments also serve to demonstrate that subcutaneous crushing or comminution of the pancreas is in itself not a fatal or even dangerous injury. Subcutaneous comminution can only prove dangerous by the site of the injury, as when, for instance, the crushing takes place at or near the outlet of the pancreatic duct, where, from cicatricial contraction, obstruction of the duct takes place which would interfere with the normal escape of pancreatic juice from the intact portion of the gland. If the comminuted tissue remains in an aseptic condition, it is removed by absorption, and the loss of substance is at least partially replaced by connective tissue, which forms a bridge between the intact portions of the gland. Subsequent degeneration, atrophy, and sclerosis take place in that portion of the gland which is no longer connected with the intestine by a permeable duct.

Complete Extirpation of the Pancreas.

A diversity of opinion still prevails among physiologists in regard to the immediate and remote effects of complete extirpation of the pancreas, or an artificial sudden suspension of its functions. The results obtained by different experimenters have led to diverse conclusions. Some claim for the pancreas an

essential part in the process of digestion, while others affirm with equal positiveness that the gland can be removed or rendered physiologically incompetent without impairing digestion. Bernard found that extirpation of the pancreas in birds produced death by marasmus in eight or ten days (*Mém. sur le Pancréas*, p. 157)

Berard and Colin removed the pancreas in a duck, and, on examining it six months later, found the site of the pancreas occupied by a thin layer of fat, which contained a few reddish nodules. No connection could be traced between them and the intestine. In pigs, part of the pancreas lies upon the portal vein, and the authors, therefore, removed only the portion adjacent to the duodenum. In one animal which died a few weeks after the operation from accidental causes, they found, in place of the portion of the pancreas removed, a cyst, the size of a hen's egg, which had no communication with the duodenum, and was filled with a fluid which, like pancreatic juice, was coagulated by alcohol. In a second case operated upon in a similar manner, the weight of the animal increased in five and a half months twenty-five kilogrammes. When the animal was killed, only a trace of the pancreatic duct could be discovered.

The portion of the gland left had undergone atrophy, and contained no ducts. The atrophied portion was eight to ten centimetres distant from the duodenum, and on section gave evidence of having undergone sclerosis. In five young dogs the pancreas was extirpated, leaving only that portion which lies upon the portal vein. All the animals remained well at the end of eight months. Three of the dogs were killed. In two of them the autopsy showed that the terminal extremity of the pancreatic duct remained as a blind pouch. The part of the gland left had become very much atrophied, and remained isolated from the duodenum. A glandular structure as large as a bean was found near the duodenum in both dogs; in one of them a duct connected this body with the bowel, while in the other no such connection could be traced. Taking it for granted that these small bodies were composed of pancreatic tissue, their weight being only about one-ninetieth part of the whole

gland, the amount of secretion from them would not have been sufficient to emulsify the fats. In the third dog no trace of the pancreas could be found, and yet the animal's digestion and health appeared to be normal. The feces contained no undigested fat. From these and other experiments of the same kind, the authors came to the conclusion that the presence of the pancreatic juice is not essential in the process of digestion or absorption of fat in herbivorous, carnivorous, or omnivorous animals, or in birds.

Schiff brought about complete suspension of the function of the pancreas in animals without removing any part of the organ by injecting the ducts of the gland with melted paraffin, which, at the temperature of the body, became a solid mass, completely obstructing the outlets for the secretion. Animals treated in this manner showed no signs of derangement of digestion, and were able to assimilate fat as well as healthy animals.

The following experiments were made to ascertain the feasibility of complete extirpation of the pancreas, and the effects of such a procedure upon digestion and assimilation. In all of the experiments the entire organ was removed. The hemorrhage was always profuse, and required numerous catgut ligatures for its arrest.

The larger vessels between the duodenum and pancreas were carefully isolated and removed with the gland, so that the intestine was deprived of its direct vascular supply over an area corresponding to the extent of the attachment of the pancreas.

Experiment VI.—Brown dog, four and a half months old; weight, 32 pounds. The entire pancreas was extirpated, part of the dissection was made with Paquelin's cautery. Temperature on second day 104° F., on fifth day 101¼° F. (subnormal). On the fourth day diarrhœa set in; stools contained undigested food and free fat, and on the seventh day blood. On the ninth day the animal died. During the first few days the appetite remained unimpaired, but when the diarrhœa supervened food was taken only sparingly. At the autopsy it was ascertained that the animal had lost five pounds in weight. The abdominal cavity contained a considerable quantity of bloody serum, and the peritoneum presented evidences of recent diffuse peritonitis.

The duodenum showed several dark spots on its convex surface, which might be taken for beginning gangrene. The pancreatic duct, traced from within the duodenum, was found closed at the point of section by a cicatrix upon the outer surface of the bowel.

Whether in this case the diarrhœa resulted from the absence of the pancreatic juice or from the septic peritonitis, would be difficult to determine. The duodenum had been detached from its mesentery at least ten inches, and yet the gangrene, if any, after nine days was limited to a few circumscribed patches.

Experiment VII.—Large black dog, four months old; weight, 48 pounds. Experience had proved that the separation of the pancreas and its vessels from the duodenum could be done more safely, and with less risk of hemorrhage, by tearing the tissues instead of using the scissors or knife, employing the cutting instruments only when it was thought imprudent to use too much violence in separating strong connecting bands, which would not yield to gentle force. In this case twelve ligatures were required to arrest the hemorrhage, in later experiments a much smaller number were found sufficient to arrest the bleeding, after I had learned to rely more freely on the tearing method in partial and complete extirpation of the pancreas. This dog never recovered fully from the operation and died on the fourth day, the temperature having remained subnormal during the whole of this time. At the autopsy a perforation in the duodenum was found on the convex side about five inches below the pylorus; recent peritonitis, which was undoubtedly produced by extravasation subsequent upon the perforation; gangrene of the bowel, circumscribed and limited to the seat of perforation, and a few other small spots on the convex surface of the bowel. Pancreatic duct at point of section not closed.

In this case death was directly attributable to gangrene of the duodenum, caused by the extensive detachment of its mesenteric vascular supply.

Experiment VIII.—Large adult cat. The operation occupied more than half an hour, and was attended by considerable hemorrhage from the deep attachments of the gastrosplenic end. The bleeding was

finally arrested by ligating a number of vessels in the region of the spleen. The animal never rallied from the operation and died five hours later with symptoms of hemorrhage and shock combined. On opening the abdomen no blood was found in the peritoneal cavity, except a few flat coagula which covered the denuded surface of the bowel, which extended seven inches in length.

Experiment IX.—Adult female cat. The extirpation was again attended by free hemorrhage, and the animal died half an hour after the completion of the operation, with symptoms of hemorrhage and shock.

Experiment X.—Adult black dog; weight, 33 pounds. Animal remained comparatively well for two days, when peritonitis supervened, which proved fatal on the fourth day after the operation. Wound closed; peritoneal surfaces separated with some difficulty. The abdominal cavity contained a quart of purulent fluid. At the same time, diffuse general peritonitis had given rise to extensive adhesions between the different abdominal organs. The duodenum appeared quite vascular and showed no signs of gangrene.

Experiment XI.—Medium-sized adult cat. After the extirpation of the entire pancreas, the duodenum was found on measurement to have been denuded of its mesenteric attachment to the extent of seven inches. The venous oozing proved free, and could not be completely arrested during the time which it was deemed prudent to keep the abdominal organs exposed to the atmospheric air. The animal never rallied from the operation and died two hours later. On opening the abdominal cavity, a considerable quantity of fluid venous blood was found. In this case death was caused by uncontrollable venous hemorrhage.

Remarks.—It will be seen that of six animals subjected to complete extirpation of the pancreas, in all of them death occurred in from a few hours to nine days after the operation. The cause of death was either the primary effects of the traumatism, hemorrhage, and shock, or from secondary pathological lesions traceable directly to the operation, as may be readily gleaned from the following table:

No.	Animal.	Time of death.	Cause of death.
1	Dog,	9 days,	Peritonitis.
2	"	4 "	Gangrene of duodenum.
3	Cat,	5 hours,	Hemorrhage and shock.
4	"	Half an hour,	" " "
5	Dog,	4 days,	Purulent peritonitis.
6	Cat,	2 hours,	Hemorrhage.

This table shows that the operation on cats proved more dangerous than on dogs, and of the three animals all died within five hours from the immediate effects of shock and hemorrhage. The three dogs died of peritonitis within from four to nine days. In one case the peritonitis was due to perforation, in the remaining two it was produced through either the wound or the pancreatic duct, which was found open in one of the cases. The complete extirpation of the pancreas necessitates such an extensive separation of the intestine from the mesentery, that this alone constitutes a great source of danger, as gangrene may take place. It is important to repeat that in the two specimens which showed evidences of gangrene this was observed on the convex surface of the bowel, and in neither case did it involve the entire diameter of the intestine. It requires no explanation to show that in cases of this kind the collateral circulation is established first on the concave side, where the vascular supply is nearest and the force of the circulation most vigorous. In dogs and cats the pancreas is attached so intimately and extensively to the duodenum that complete extirpation is necessarily attended by profuse hemorrhage, which often was found difficult, and in one instance impossible, to control. Ligation of some of the bleeding points was often found impossible, as any attempt in seizing the vessel necessarily grasped the muscular coat of the bowel, which it was thought to be dangerous to include in the ligature, as it might give rise to perforation. Steady pressure with a sponge wrung out of a hot, weak solution of corrosive sublimate was found to be the most reliable means in arresting troublesome oozing. None of these experiments was

sufficiently successful to study the effect of complete extirpation of the pancreas upon digestion and assimilation.

In a number of the autopsies, however, the lacteals contained a milky fluid, showing that at least a portion of the fatty food had been emulsified by other secretions. As a final conclusion, I do not hesitate to affirm that in dogs and cats complete extirpation of the pancreas is always followed by death, either from the primary effect of the operation, or the secondary consequences following it.

Partial Extirpation of the Pancreas.

Partial extirpation of the pancreas implies a less degree of traumatism, and consequently less danger of causing serious nutritive changes in adjacent organs than complete extirpation, and for these reasons it is less dangerous, in a strictly surgical sense. Physiologically, a partial extirpation of the organ may imply the same consequences as complete extirpation, as when the portion of gland removed embraces the common duct or both principal ducts from each portion of the gland.

Experiment XII.—Adult cat; weight, 6½ pounds. Pancreas drawn into the abdominal wound with the duodenum, and separated from the bowel to the extent of two inches, at a point corresponding to the middle portion of the gland. This section of the gland, which included the termination of the ducts, was excised with Paquelin's cautery; only one artery from the gastrosplenic end required ligature; ends of gland dropped into the abdominal cavity. The temperature remained subnormal, 101° F., until the animal died, two days after the operation. At the autopsy, gangrene and perforation of the duodenum were found at a point corresponding to the site of resection.

Experiment XIII.—Scotch terrier; weight, 25½ pounds. Ligated pancreas at its middle, with catgut, and extirpated the gastrosplenic portion; eight ligatures were required to control the hemorrhage and about four inches of the duodenum were denuded of its mesentery. Second day after the operation the temperature was 100.4° F., which became normal (103° F.) on third day. During the first week the

animal gained one pound in weight, showing that digestion was not disturbed by the absence of the pancreatic juice during this time.

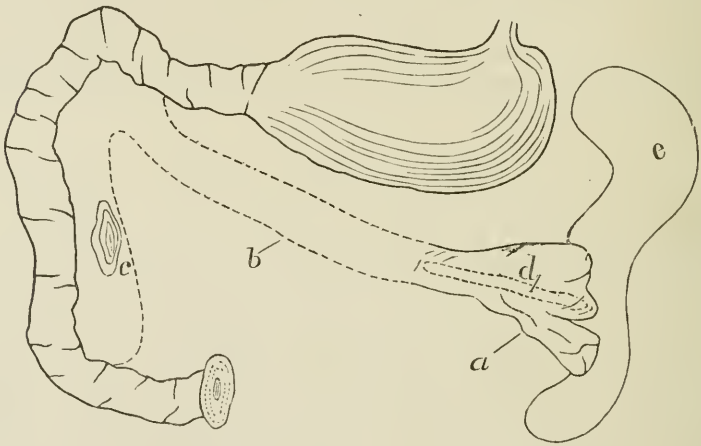
Three weeks after the operation the dog began to lose flesh; the emaciation was progressive until the animal died of marasmus seventy-six days after the operation. During this time the appetite was not impaired, and at no time had diarrhœa been observed. The organs of the chest were found in a normal condition. The abdominal wound was firmly united. A few adhesions between the omentum and parietal peritoneum. No signs of peritonitis. The parenchyma of the duodenal portion of the gland had disappeared completely by absorption, only the connective tissue and the duct, somewhat dilated, remaining. The idea that degeneration and absorption of the parenchymatous structure of the gland were caused by local anæmia could not be entertained for a moment, as the connective tissue frame of the gland was freely supplied with numerous and large vessels. The portion of the duodenum stripped of its mesentery was repaired by a vascular strip of connective tissue, which restored the continuity of the mesenteric circulation. The common pancreatic duct was found obliterated at its point of entrance into the bowel, where it had been divided during the operation.

Experiment XIV.—Adult cat; weight, 6 pounds. Extirpation of gastrosplenic and half of the duodenal portion of the pancreas, with separation of duodenal mesentery to the same extent. The portion of the gland which remained was not ligated. The animal rallied from the immediate effects of the operation, but died eighteen hours later in convulsions. At the autopsy the mucous membrane of the duodenum in the portion of the bowel which had been deprived of its direct vascular supply, presented a cyanosed appearance, but no distinct signs of gangrene. Abdominal cavity contained no fluid of any kind; peritoneum normal in appearance. Slight hemorrhage between peritoneum and transversalis fascia.

Experiment XV.—Large adult dog; weight, 48 pounds. Extirpation of two-thirds of the pancreas with the common duct, leaving only a portion of the remote end of the gastrosplenic portion. The hemorrhage, which was profuse, was carefully arrested, and the pancreas ligated before section. The first two days the temperature was subnormal, 101°–102.2° F. On the third day it became normal and remained so. The animal remained in perfect health for four weeks, when he commenced to lose flesh. Appetite voracious. No diarrhœa,

but stools contained undigested fat. Although the animal ate as much as four dogs of similar size, emaciation continued, and had become extreme when the dog was killed, 126 days after the operation. At the autopsy the abdominal incision was found adherent to the mesentery. The duodenum which had been stripped of its mesentery was found free, without a mesenteric attachment, but freely supplied with blood by two large vessels running through a band of connective tissue adherent to the bowel on the concave denuded side. The vessels were in communication with the adjacent intact mesenteric vessels, and served to complete the interrupted mesenteric circulation. The gastro-splenic portion of the gland which was left behind was found completely atrophied; in its centre the duct could be seen dilated to the size of a leadpencil, and distended by a clear, transparent fluid. The dilated duct had no communication with the bowel. (Fig. 6.)

FIG. 6.



a. Remnant of pancreas.
b. Dotted lines, outline of normal position of gland.
c. Connective tissue nodule.
d. Duct.
e. Spleen.

REMARKS.—As in all of these experiments the common ducts were removed with the excised portion of the pancreas, it left the animal physiologically in the same condition as after complete extirpation of the organ, as no pancreatic juice could find

its way into the intestine. In Experiments XIII. and XV. the dogs lived for a sufficient length of time to determine the influence of the pancreatic secretion upon digestion and assimilation. In both of these animals the general health and nutrition remained unimpaired for four weeks, when emaciation, with fatty stools, followed, which resulted in death from marasmus in one, after seventy-six days, and reduced the second dog to a skeleton in one hundred and twenty-six days. As from the beginning no pancreatic juice found its way into the intestine, it is difficult to account for the satisfactory condition of digestion, and the appearance of health of the animals for the first four weeks, followed by a progressive marasmus and increase of appetite. It is true that by the resection of the mesentery of the duodenum intestinal absorption was correspondingly diminished, but marasmus from this source ought to have manifested itself soon after the operation. It is now generally conceded that a healthy pancreas will absorb its own secretion in case there is any obstruction to prevent the normal escape of the pancreatic juice, and it may be that pancreatic juice entering the circulation in this manner may have some as yet unexplained action on digestion. Should this be the case, we might assume that the pancreatic tissue left behind continued to secrete until the parenchyma was incapacitated by degenerative changes to perform this function.

All of the above experiments made on the pancreas tend to prove that any portion of the gland when it becomes detached from the bowel, invariably undergoes degenerative changes, and that its parenchymatous structure disappears by absorption within a few weeks. In these cases we may safely assume that the remaining portion of the gland had been rendered physiologically incompetent during the first four weeks, the time during which the animals remained in a healthy condition. In Experiment XV. almost the entire duodenum had been suddenly deprived of its vascular supply, and yet no gangrene occurred. The collateral circulation was established by the development of two large vessels in a band of cicatricial tissue along the concave surface of the bowel, which restored the interrupted circu-

lation between the mesenteric vessels on each side of the resected portion of the mesentery. It is also important to mention that in both dogs the lacteals appeared empty at the autopsy. These experiments would then tend to prove that the pancreatic secretion is an important, if not essential, digestive fluid, and that in cases where no pancreatic juice can enter the intestine, or where the secretion is entirely suspended, digestion and assimilation become impaired, in all cases where the supposed vicarious action of other organs is inadequate to perform the functions of the extirpated or degenerated pancreas.

Obliteration of the Pancreatic Duct by Elastic Constriction.

A favorite method of studying the effect of exclusion of the pancreatic juice from the digestive tract has been ligation of the pancreatic duct. Against the reliability of these experiments it may be urged that in many animals the pancreas possesses more than one duct, and in some of them accessory ducts may be present, which in all probability would be overlooked in the operation, and thus complete exclusion would not be secured. In some of the smaller animals even the common duct is often found only after a prolonged and patient search, consequently any additional ducts or ductlets would be very likely to escape the attention of the operator. Rabbits have, as a rule, only one duct, which enters the intestine eight to ten inches below the pyloric orifice of the stomach; on this account the results obtained by experiments of ligating the duct have been most reliable when this animal was taken as an object for experimentation.

Amozan and Vaillard (Pancréas du Lapin, *Journ. de Méd. de Bordeaux*, April 3, 1881) tied the pancreatic duct in rabbits, and studied subsequently the histological changes in the pancreas. Animals that survived the operation, and were killed after eight days, were considerably emaciated. On examining the pancreas it was found, as in the parotid gland, after tying its duct, that an excessive amount of connective tissue had formed in and around the lobules, that the ducts were much dilated, and

the epithelial lining partly thrown off; the epithelial cells had changed in position and form, and appeared atrophied. A careful microscopical examination of the specimen showed that ligation of the duct of Wirsung produced a gradual transformation of the pancreas into connective tissue; the first effect is an enormous distention of the duct which extends to the most remote portions of the gland. The epithelial cells become detached, and with a colloid material present, lead to obstruction in the ducts. The gland cells, even as early as twenty-four hours after ligature, become translucent. After a few days the nuclei become swollen, and divide into two or three parts, which fill the interior of the cell. After seven to nine days, the place of the cells is occupied by free nuclei and round and spindle-shaped cells, which are transformed into connective tissue. In the neighborhood of some of the veins collections of colorless corpuscles could be seen. The gland, on the whole, had undergone cirrhotic atrophy.

According to Charcot and Gombault, the same cirrhotic change is produced in the liver by ligating the bile-ducts, while ligation of the ducts of the salivary glands and the ureters of the kidney produces only slight or no cirrhosis of those organs.

Bérard and Colin (*Gaz. hebd.*, vi. 4, 1858) ligated the pancreatic duct in dogs which had fasted for several days, and then fed them well for twenty-four hours. The animals either showed no appetite, or, after eating, ejected the food from the stomach. If the animals were killed the lacteals were either only partially filled with a milky fluid, or, more generally, they were found empty.

The authors then tied the pancreatic duct in sixteen dogs which had fasted four or five days, and immediately injected into the duodenum a quantity of oil and lukewarm water. The animals were killed three or four days afterward, and the lacteals were found to contain a white opaque chyle both in the mesentery and walls of the intestine.

Cohnheim (*Allgemeine Pathologie*, Berlin, 1882) claims that digestion is performed in a remarkably satisfactory manner, even in case the pancreatic juice is entirely absent, in the intestinal

tract. He claims that the presence of fatty stools is the only symptom which can be positively brought in connection with a defective or total absence of pancreatic secretion. He asserts that in rabbits it is not difficult to ligate the pancreatic duct, and that in cases where this is done, with the exception of a loss of appetite for a few days, the animals suffered no bad consequences, and in a few days were as well as before the operation.

Langendorf ascertained by experiment that in pigeons a few days after obliteration of the ducts of the pancreas, the desire for food increased, but they emaciated progressively, because, as the author asserts, the carbohydrates were not digested. Cohnheim is of the opinion that in other animals the capacity of other organs to assume vicarious action is greater than in birds. Other digestive fluids perform the function of the pancreas. The transformation of starch into glucose is accomplished by the intestinal juice, and the emulsifying action of the pancreatic juice is assumed by the bile. The remnants of undigested peptones are removed by way of putrefaction induced by bacteria, which are always present in the intestinal tract. That the pancreas continues to secrete after ligation of the common duct has been demonstrated in Heidenhain's laboratory, where, thirty days after the duct had been ligated, normal pancreatic juice escaped through a canula introduced into the duct. The quantity was only slightly less than from a normal gland, and the discrepancy was readily explained, as some of the gland structures must have been destroyed by the increased pressure in the duct from the accumulated fluid. As the organ continues to secrete, and the space for accumulation is limited, the only logical conclusion which can be arrived at is that the secretion is removed by the bloodvessels and lymphatics in the gland. It has been shown by Künne that the introduction of pancreatic juice into the circulation does not act deleteriously, as he injected one of its most active constituents—trypsin—directly into a vein without any immediate or remote ill effect upon the animal. As he detected this substance in the urine, it is reasonable to assume that the ferments of the pancreatic juice which have not been

neutralized by deoxidation into the more innocuous zymogen are eliminated with the renal excretions.

The following experiments were made, not so much to determine the effect of ligation of the pancreatic duct upon digestion, as with a distinct purpose of studying the effects, in the gland and its duct, which would follow sudden obstruction in the duct. Instead of resorting to direct ligation of the duct, the same object was accomplished with greater certainty and more ease by resorting to elastic constriction by using a rubber tube or band which was made to include the entire pancreas with or without its vessels. In every instance the elastic constriction produced complete division of the organ and its duct in a short time, and the ligature was usually found encysted either at the site of application or a little distance from it.

Experiment XVI.—Adult black dog; weight, 30 pounds. Pancreas and duodenum were drawn into the abdominal incision, and a fine rubber drainage tube was passed between the duodenum and the pancreas at the junction of the middle with the proximal third, and firmly tied. The knot was kept from unfastening by transfixion with

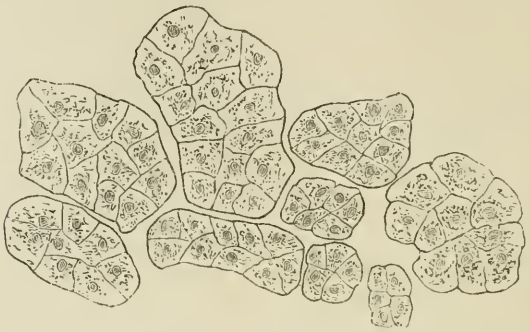
Fig. 7.

Normal Microscopic Appearance of Parenchyma Cells from Duodenal Portion.

a silk ligature. The vessels were included in the rubber ligature. The animal remained perfectly well after the operation and gained three and a half pounds in ten days. The dog was killed forty-nine days after the operation. On examination it was found that the abdominal wound had healed completely; slight adhesions between

omentum and the lower portion of the cicatrix. The rubber ligature was found encysted at the junction of the middle with the proximal third (splenic end). The duodenal portion and the distal portion of

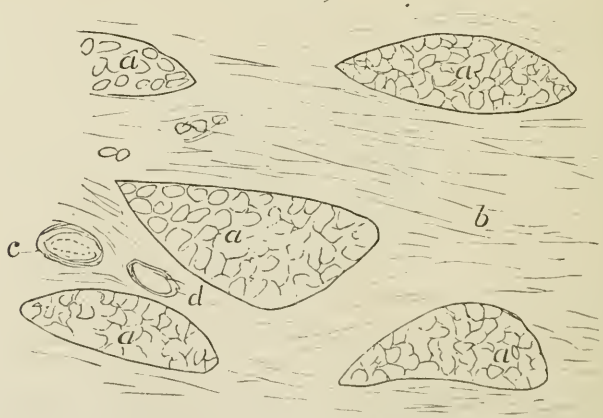
FIG. 8.



MICROSCOPIC APPEARANCE OF PARENCHYMA CELLS IN ISOLATED SPLENIC PORTION. × 500.

the gastrosplenic end were unchanged, as the secretion could enter the intestine through the patent common duct. At the point where the ligature had been applied, the organ, with its duct, had been com-

FIG. 9.



SCLEROSIS OF SPLENIC END. × 50.

a. Lobes showing fatty degeneration.
b. Connective tissue.
c. Artery.
d. Vein.

pletely divided, the point of section being indicated by a contraction due to cicatrization. The duct in the isolated splenic portion was slightly dilated; parenchymatous tissue in a state of degeneration; well-marked sclerosis. (Figs. 7, 8, 9.)

EXPERIMENT XVI*a*.—White and yellow coach dog, four and a half months old; weight, 32 pounds. In this case the rubber ligature was applied about the middle of the gland, including the artery, but not the vein. The animal remained in excellent health, and was killed ninety-eight days after the operation. At the autopsy the ligature was found encysted in a firm capsule about the middle of the gland. It had completely divided the pancreas and the duct of the splenic portion on the proximal side of the common duct. The duct in the isolated portion was considerably dilated throughout, and completely obliterated at the point of ligation. This portion of the gland had undergone parenchymatous degeneration and sclerosis, as the tissue was quite firm and grated on being cut with the knife. The portion of the gland remaining in communication with the intestine through the common duct presented a normal appearance.

EXPERIMENT XVII.—Adult black dog; weight, 20 pounds; ligation of pancreas on the proximal side of the common duct, excluding the artery. The dog remained perfectly well after the operation, gained considerable flesh, and was killed in four weeks. The rubber ligature was encysted between the duodenum and pancreas. Complete division of pancreas and duct on the splenic side of the common duct. Slight dilatation of the duct in isolated portion, with the same tissue changes as in the preceding case.

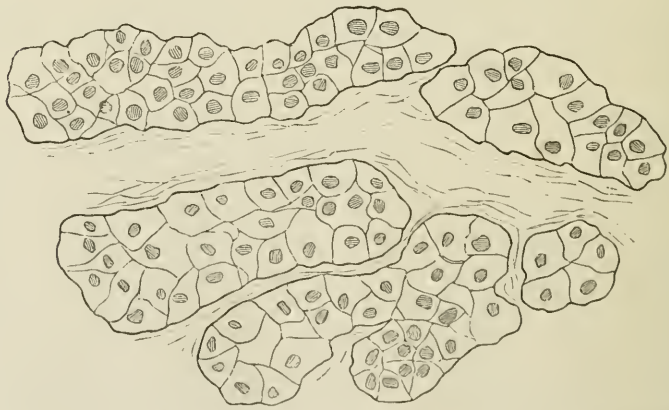
EXPERIMENT XVIII.—Adult black cat; weight, 5½ pounds. The pancreas was detached from the duodenum to the extent of three-quarters of an inch, and the rubber ligature applied so as to exclude the artery. On the second day the temperature rose to 106° F., but the general condition of the animal was undisturbed. The fever soon subsided, and digestion and nutrition were at no time impaired. The cat was killed thirty-eight days after operation. The ligature was found encysted between the pancreas and duodenum on the distal side of the common duct. Complete division of the pancreas and obliteration of the duct by a linear cicatrix. The detached mesentery was united with the bowel. The detached duodenal portion of gland had almost dis-

appeared by absorption, only connective tissue and vessels being left to indicate the contour of the gland. (Figs. 10, 11, 12, 13.)

FIG. 10.

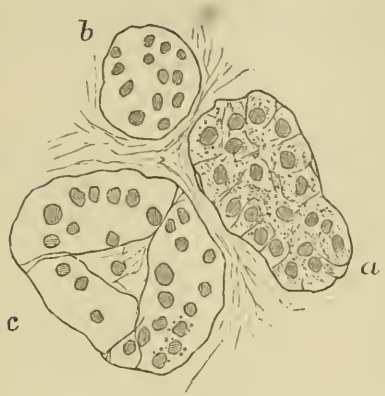
M. Point from which microscopical sections showing normal cells were taken.
M'. Point from which microscopical sections showing degenerated cells were taken.
a. Ligature.

FIG. 11.



SECTION TAKEN FROM M, SPLENIC PORTION, SHOWING NORMAL PARENCHYMA. × 500.

FIG. 12.



INCOMPLETE FATTY DEGENERATION, FROM DUODENAL PORTION OF GLAND. × 500.

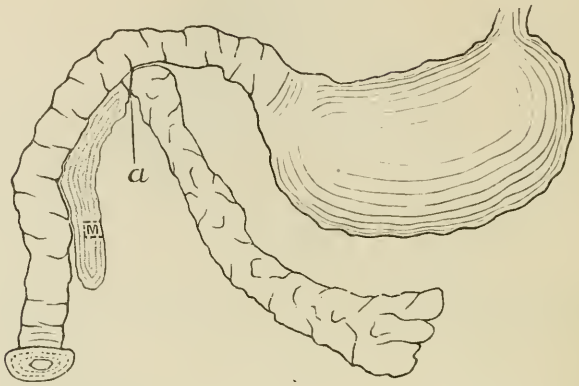
FIG. 13.

COMPLETE FATTY DEGENERATION, FROM DUODENAL PORTION OF GLAND.
a. Artery.

EXPERIMENT XIX.—Adult white cat; weight, 6½ pounds. Detached pancreas and vessels from duodenum to the extent of an inch and a half, and applied a rubber ligature about the middle of the gland, including the vessels. Next day the temperature was 105° F.; later, normal. No disturbance of digestion or nutrition. The cat was killed eighty-five days after operation. The rubber ligature was encysted between duodenum and pancreas on distal side of the common duct. Complete section of pancreas and obliteration of duct. The duodenal portion had almost completely disappeared by absorption; the connective tissue of the gland, the dilated ducts, and the abundant vascular

supply, served to indicate the outlines of the atrophied portion. Mesentery of the duodenum was perfect. (Fig. 14.)

FIG. 14.



a. Ligature.

M. Portion taken for microscopical examination which showed complete absence of parenchyma cells.

EXPERIMENT XX.—Young black cat; weight, 2 pounds. Isolated pancreas to the extent of two inches from intestine, and included the detached portion between two silk ligatures, firmly tied. Temperature was high on second and sixth days. Animal died on sixth day. Abdominal wound was firmly united. On opening the abdominal cavity no effusion was found. No general peritonitis. Abscess between duodenum and liver; ligated portion detached, gangrenous; ligatures not encysted. Abscess in communication with pancreas. Acute atrophy of the entire pancreas. No gangrene of duodenum. In this case the suppurative process started from the portion of pancreas which had been included between the ligatures. We shall find that when infection does not take place, even isolated dead pancreatic tissue is amenable to absorption.

EXPERIMENT XXI.—Old cat; weight, 4 pounds. Detached gastro-splenic portion of the pancreas to the extent of an inch and a half from duodenum, and applied two rubber ligatures about one-half of an inch apart, including the vessels. On the following day the cat was quite ill, without any rise in temperature. For several days vomiting was the most prominent symptom. The animal died on the sixth

day. Abdominal wound united; no peritonitis; no effusion. Pancreas adherent to transverse colon: on separating the adhesion a small cyst containing about three drachms of a clear, transparent fluid was ruptured. As this cyst corresponded to the place where the ligatures had been applied, it was undoubtedly a collection of pancreatic juice which had escaped from the divided duct, and around which a connective tissue wall had formed. The ligatures had cut through the organ and duct. The ends of the gland had retracted. Duodenum healthy. Mesenteric detachment not repaired. No suppuration anywhere.

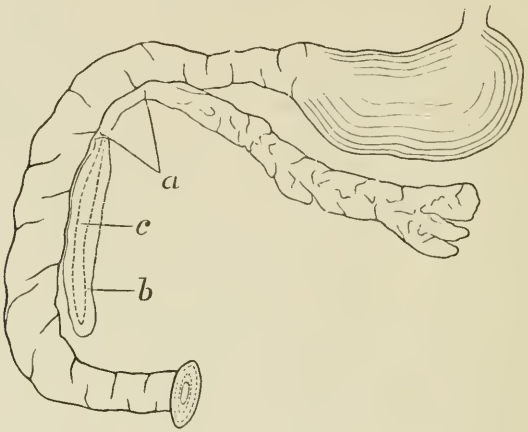
Experiment XXII.—Adult dog; weight, 39 pounds. Detached the pancreas, about its middle, from duodenum, to the extent of two inches, and applied two rubber ligatures, about one inch apart, including the vessels. On the following day the dog appeared quite sick. Increase of temperature after sixth day; no appetite, and rapid emaciation. On the ninth day, diarrhœa, which became later dysenteric in character. Died on the nineteenth day, having lost during this time six and a half pounds in weight. Abdominal wound completely united. No general peritonitis. Pancreas and duodenum adherent to liver. Portion of pancreas between ligatures gangrenous—contained in an abscess cavity. Ligatures detached and loose in abscess cavity.

Experiment XXIII.—Adult black dog; weight, 20 pounds. Inclusion of two inches of pancreas and its vessels, after separation from duodenum, between two silk ligatures about the centre of the gland. The dog was very sick on second day, and thermometer showed an increase of temperature to 104.4° F., which continued with slight variations until the animal died on the sixth day. Wound completely united. Diffuse purulent peritonitis, and extensive adhesions. Ligated portion gangrenous and loose, with ligatures in abscess cavity between duodenum and pancreas.

Experiment XXIV.—Adult gray cat; weight, 5¾ pounds. Isolated pancreas and vessels from duodenum to the extent of an inch and a half, and included this portion between two ligatures. Animal remained well for four days, when symptoms of peritonitis appeared. Died on tenth day. Wound nicely united. No peritoneal effusion. Localized peritonitis at site of operation. Ligatures and ligated section of pancreas loose in abscess between the duodenum and pancreas. Pancreatic veins thrombosed. Duct of splenic portion in direct communication with the abscess cavity.

Experiment XXV.—Adult cat; weight, 6 pounds. Pancreas with its vessels detached from duodenum to the extent of two inches, and this portion included between two ligatures. On fifth day temperature 106° F., gradual decrease subsequently to normal. For a number of days during the febrile attack, complete loss of appetite. After this, appetite and nutrition were good. Killed twenty-eight days after operation. Portion of gland between ligatures completely disappeared by absorption. Ligatures in close proximity and encysted in firm capsule. Duodenal end atrophied, in which the dilated duct was distinctly visible. Splenic end somewhat atrophied. (Fig. 15.)

Fig. 15.



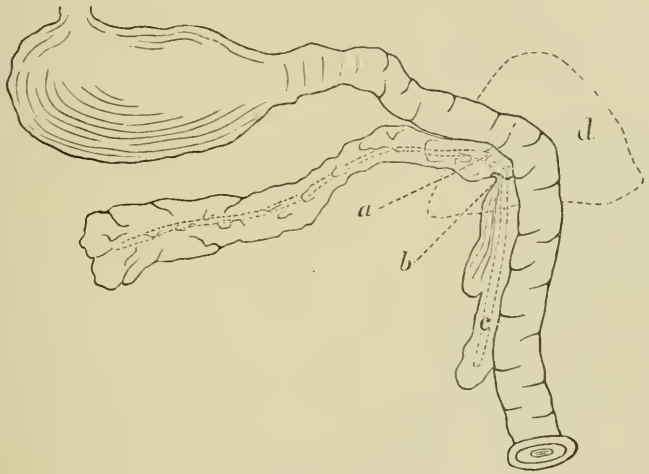
a. Ligatures.
b. Duodenal portion atrophied and undergoing fatty degeneration.
c. Dilated duct.

Experiment XXVI.—Large Newfoundland dog; weight, 55 pounds. Rubber ligatures made to include one inch of the pancreas about its middle, with exclusion of its vessels. Slight fever on third day, subsequently no symptoms indicating disturbance of digestion or disease. Animal killed thirty-one days after operation. Intervening portion of pancreas disappeared by absorption. Ligatures encysted. Loss of substance replaced by bridge of connective tissue. Duodenal end atrophic with dilated duct. Gastrosplenic portion normal in appearance, and in direct communication with the intestine through the common pancreatic duct.

Only two of the animals recovered after isolation and double ligation of the pancreas, a fact which shows the great danger of leaving in the abdominal cavity pancreatic tissue not supplied with blood. We can only assume that the danger of infection is increased by leaving an exceedingly favorable culture substance for infective germs in the abdomen. If the operation is perfectly aseptic, the dead pancreatic tissue remains aseptic, and is removed in an exceedingly short time by absorption.

Experiment XXVII.—Large adult cat. Applied a single rubber ligature on distal side of the common pancreatic duct, excluding the artery and vein. No disturbance of digestion or nutrition, and temperature normal throughout. Animal, when killed twenty-eight days

Fig. 16.



Posterior View.

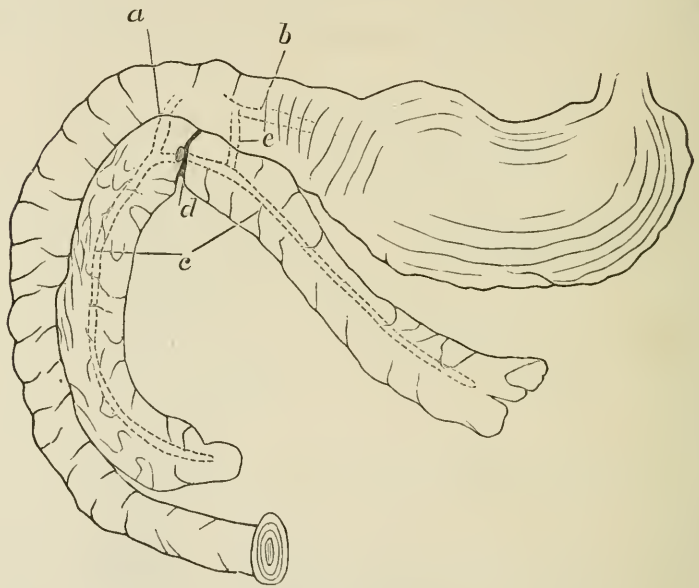
a. Common duct.
b. Ligature.
c. Duodenal portion, atrophy and fatty degeneration marked, duct dilated.
d. Liver, pancreas adherent to.

after operation, had grown fat. Only a few slight adhesions at site of ligation. Pancreas and duct were completely divided by the ligature, the ends kept in contact by a linear cicatrix. Ligature was encysted between the duodenum and under surface of the liver. The gastro-

splenic portion of the pancreas was normal in appearance, and connected with the common duct. The duodenal portion was atrophied; the duct slightly dilated. (Fig. 16.)

Experiment XXVIII.—Large Newfoundland dog. Ligation of the pancreas and its vessels with a rubber ligature on the proximal side of the common duct. No fever, no disturbance of digestion or nutrition. Animal was killed ninety-one days after operation. On opening the abdominal cavity, the entire pancreas presented a normal appearance in size, shape, and consistence. Where the ligature was applied a narrow constriction was visible, which represented the point of section

Fig. 17.



a. Duct of Wirsung.
b. Ductus choledochus.
c. Main pancreatic ducts.
d. Ligature.
e. Accessory duct.

made by the ligature. Ligature was encysted in the cicatrix. On tracing the pancreatic duct from the interior of the intestine, a probe could be passed along the duct of the duodenal portion. On following the duct of the splenic portion, the probe was arrested at the cicatrix,

about a quarter of an inch from the wall of the intestine. The duct at this point was completely obliterated. As in all of the previous experiments the detached portion of the gland had invariably become the seat of degenerative changes and atrophy, I was at a loss to account for the normal appearance of the gastrosplenic portion of the gland in this instance. After a prolonged and careful search a minute opening was detected in the fold of the mucous membrane surrounding the outlet of the bile-duct, and by careful manipulation a delicate probe was passed along a canal which passed obliquely through the wall of the bowel, entered the pancreas on the splenic side of the ligature, and terminated in the large duct of the gastrosplenic portion. (Fig. 17.)

The explanation for the absence of atrophic changes had been found. An accessory duct had furnished an outlet for the secretion in the gastrosplenic portion, and had maintained the physiological connection between this portion of the gland and the duodenum after obliteration of the common duct of the gastrosplenic portion. It was the only instance where such a structure was detected, and the only specimen in which the normal structure of the detached portion of the gland was preserved after obliteration of the principal duct.

Remarks.—These experiments illustrate the feasibility of ligation of either portion of the pancreas near the common duct as a surgical procedure, and the regularity with which the pancreatic tissue is removed by degeneration and absorption in the detached portion of the gland. By physiological detachment, I mean again a permanent interruption to the escape of secretion by section or obliteration of the duct.

After ligation of the duct or gland, secretion continues, and as the space for accumulation of the fluid is limited, a certain degree of pressure within the duct is established, as is evident from the uniformity with which the ducts throughout that portion of the gland were found dilated. In no instance, however, was anything observed which resembled a cyst. The dilatation was not limited to any particular portion of the duct, it always presented itself as a uniform ectasia of the entire duct. We can only explain the moderate dilatation by assuming that, as soon as a certain degree of pressure is reached, the pancreatic juice is removed by absorption by the vessels and lymphatics of the

pancreas, and that a greater accumulation of fluid and distention of the duct could only occur when this function has become diminished or suspended by organic changes in the structures which are concerned in the removal of the secretion. The atrophic changes in the parenchyma of the detached portion of the gland have been ascribed to the pressure within the ducts upon the parenchyma cells—a sort of pressure atrophy.

This supposition lacks proof, inasmuch as the pressure at any time could not have been considerable, and as the same atrophic changes have been observed in cases where no pressure could have existed, as in cases of external and internal pancreatic fistula, where the duct remains open until secretion ceases. The atrophy can also not be due to deficiency of blood supply, as it occurred regularly and as rapidly in cases where the blood supply remained unimpaired; and in many of the specimens, illustrating complete atrophy, the abundant vascular supply was distinctly observed and noted. I am unable to furnish a satisfactory explanation of the cause of this form of atrophy. All that I can say is, that in every instance in which complete physiological detachment had been produced by ligation, resection, crushing, or any other means, this result followed without exception.

Practically this observation is of great importance, because it demonstrates that in operations upon the pancreas it is not essential or necessary to remove peripheral portions of the gland, for fear that if any of the parenchymatous structure should remain a retention cyst would follow. In partial resections for injury or disease it would be advisable to ligate the peripheral portion, and permit it to remain, as it would lessen the danger by the infliction of less traumatism, and we can confidently expect that it will be removed in a short time by absorption.

These experiments settle definitely an important pathological question. It has been claimed by all writers that cysts of the pancreas are produced by obstruction of the common duct. In most of the specimens which have been examined, it is distinctly stated that the obstruction was not complete, as, for instance, in

cases of impaction of pancreatic calculi when found in connection with cysts. In all of these experiments obstruction of the duct was sudden and complete by the elastic constriction, and subsequently permanent by the formation of a cicatrix between the divided ends of the duct.

In none of the specimens, where life was sufficiently prolonged, did the process of obliteration fail to take place, and yet in none of them was even an attempt at the formation of a cyst observed.

The experiments with the double ligature teach the importance of removing such portions of the pancreas as are not supplied with bloodvessels, rather than trust to the doubtful expedient of leaving them to be removed by absorption, as dead pancreatic tissue is an exceedingly putrescible substance, and furnishes the most favorable conditions for the growth and increase of septic germs.

External Pancreatic Fistula.

The formation of a permanent pancreatic fistula has always constituted one of the most difficult tasks in experimental physiology. Bernard (*Leçons de physiol. expér. appliquée à la médicine*, t. ii., Paris, 1855), after many fruitless attempts, declared that it was impossible to establish a permanent pancreatic fistula, for the reason that the canula invariably fell out after a few days, after which the duct again conveyed its contents into the duodenum. He found, also, that the pancreatic juice which flowed from the fistula remained normal for only twelve or sixteen hours, after which time it became thinner, and did not coagulate on the application of heat. Neither did it possess any longer the property of decomposing fat into glycerine and fatty acids. This change in the pancreatic juice always appeared as soon as inflammation was noticed about the seat of operation. In horses and cattle this condition appeared so early, that it was found impossible to obtain pure pancreatic juice from a fistula.

The intermittent action of the pancreas is well illustrated

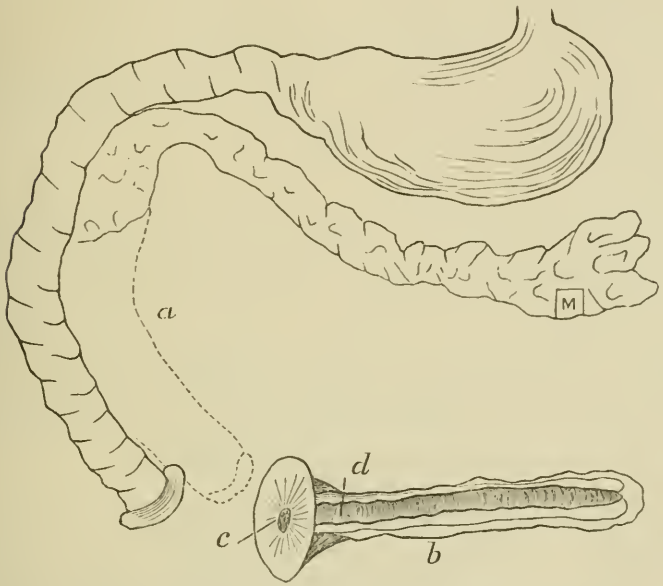
in animals when a fistula has been established, active secretion taking place only during digestion. Bernard ascertained that in medium-sized dogs, in an hour, not more than five or six grammes of juice could be obtained. Ether injected into the stomach increased the secretion, while vomiting suspended the flow of fluid, but not its secretion, since just after the act it was poured out in so much greater quantities. Pressure on the abdomen and the respiratory movement of the chest accelerated the flow from the fistula.

The following experiments were made for the distinct purpose of studying the functional activity of a detached portion of the pancreas, consequently a different method of operating had to be devised. Having satisfied myself that physiological detachment of a portion of the pancreas by section, resection, or ligation always results in degeneration of the parenchyma, and atrophy of the detached portion, I determined to study this subject more thoroughly by interrupting all anatomical continuity between the detached and the principal portion of the gland. An external pancreatic fistula was established by bringing the pancreas with the duodenum into the wound, ligating the pancreas usually below the common duct, dividing the gland and its vessels completely on the distal side of the ligature, arresting carefully the hemorrhage from the cut surface without interfering with the principal duct, detaching the distal, or duodenal portion sufficiently from the bowel, so as to bring the cut surface a little above the level of the outer surface of the wound, where it was fixed with four catgut sutures to the margins of the wound. The remaining portion of the wound was closed in the usual manner. This method secured a permanent pancreatic fistula, the outflow from which would indicate the amount of secretion from the detached portion of the gland.

Experiment XXIX.—Young dog; weight, 30 pounds. Ligated pancreas at junction of middle with distal portion, section of gland immediately below ligature, separation of detached portion from duodenum to the extent of two inches, implantation of free end into

the lower angle of the abdominal incision with four catgut sutures. During the second day, slight rise in the temperature. During the first day the dog refused to eat, and no pancreatic juice was seen to escape from the cut surface of the gland. The second day the secretion was copious, resembling normal pancreatic juice. The discharge was intermittent, most copious a few hours after eating, and entirely absent when the animal fasted. At the end of the first week, the secretion became less in quantity, and gradually continued to decrease

FIG. 18.



a. Point of division of gland.
b. Portion of gland planted into wound, showing complete atrophy.
c. External cicatrix.
d. Dilated duct.
M. Portion taken for microscopical sections, showing normal structure of gland.

until it ceased entirely on the twenty-first day. The portion of the pancreas included in the wound became smaller from day to day, and appeared to have disappeared almost entirely when the secretion ceased, leaving at this place an irregular depressed cicatrix, with no tendency to hernial protrusion. The animal remained in perfect health and was killed seventy days after operation. At the autopsy, the cut end of

the atrophic duodenal portion of the pancreas was found adherent to, and incorporated in the firm cicatrix of the abdominal wound. The parenchyma in the detached portion of the gland had disappeared completely; in the centre of this portion the principal duct could be seen dilated to the size of a lead-pencil, and it contained a clear, transparent fluid. The duct could be traced to the peripheral extremity of the gland in one direction, and into the cicatrix of the abdominal wound in the other. The atrophic portion of the gland was freely supplied with bloodvessels. The duct was widest near the cicatrix, and gradually tapered toward the end of the gland. The cut proximal end had become adherent to the duodenum. A probe could be passed from the duodenal end of the common pancreatic duct along the entire distance of the splenic portion; the point of section had evidently been made on the peripheral side of the common duct, through the duodenal portion of the gland. (Fig. 18.)

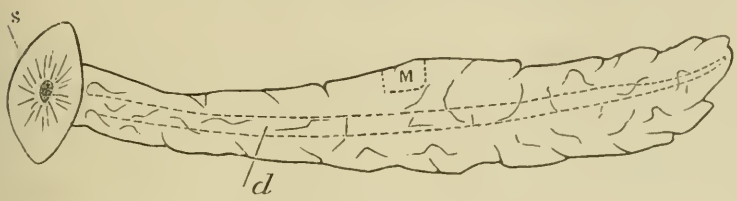
Experiment XXX.—Adult cat; weight, 5 pounds. In this case the gland was divided near the middle. The duodenal portion was detached from the intestine to the extent of two inches, and sewed into the lower angle of the incision. Second day temperature, 105.8° F. The animal took but little food, and only a very small amount of secretion was observed to escape from the duct on the cut surface of the gland. The cat died on the third day, after the temperature had shown an increase to 106° F. At the autopsy it was shown that death had resulted from purulent peritonitis, and croupous pneumonia of right lung. No gangrene of duodenum or pancreas.

Experiment XXXI.—Adult cat; weight, 5¾ pounds. Operation same as before. The animal was quite ill for three days; at the end of this time the temperature was 104.8° F.; took but little nourishment. From this time improvement took place, and finally complete recovery. Escape of pancreatic juice was first observed on second day; it gradually increased for three days, when it began to diminish and ceased completely on the seventeenth day, when the wound closed completely, showing no tendency to ventral hernia. Unfortunately the animal was lost on the forty-eighth day.

Experiment XXXII.—Black shepherd dog; weight, 43½ pounds. Ligation of pancreas about its middle, double ligation of pancreaticoduodenal artery, division of gland, application of four ligatures to arrest

hemorrhage from the distal portion of the gland, detachment of duodenal end to the extent of two inches from intestine, and fixation of free end into the lower angle of the incision by four catgut sutures. No

FIG. 19.



EXTERNAL PANCREATIC FISTULA.

s. Portion of skin with external cicatrix in centre.

d. Dilated duct.

M. Portion taken for microscopical examination, showing advanced fatty degeneration of parenchyma, and sclerosis throughout entire transplanted portion of gland.

untoward symptoms after operation. Free escape of pancreatic juice at the end of the second day, which continued quite profuse for ten

FIG. 20.

EXTERNAL PANCREATIC FISTULA, FROM DUODENAL PORTION OF GLAND.

Some of the acini completely empty, others show groups of cells in advanced stage of fatty degeneration.

days during digestion, when it began to diminish, and ceased entirely on the twenty-fifth day after the operation. During the first six days the animal lost four pounds in weight, after this time digestion and

nutrition were perfect. The dog was killed forty-six days after operation. Post-mortem appearance was almost identical with that in Experiment XXIX., except that the duodenum was found adherent to the under surface of the liver. The vascularity of the atrophic duodenal end was particularly well marked. (Figs. 19, 20.)

Remarks.—These experiments have demonstrated conclusively that when a portion of the pancreas is detached by complete section, secretion continues until, by degeneration and absorption, the parenchyma of the gland has disappeared. The degeneration evidently commences at the end of eight to twelve days, and progresses rapidly and continuously until the end of twenty to twenty-seven days, when all of the secreting structures have lost their physiological function, as indicated by a permanent cessation of the flow of pancreatic juice. The existence of distention of the principal duct in these cases can only be explained by assuming that it occurs after closure of the fistula has taken place by an accumulation of secretion from the lining of the duct, or that the dilatation is caused by traction upon the outer surface of the duct by the connective tissue framework of the gland, or the contraction incident to interstitial connective tissue proliferation. That the atrophy in the part of the organ which had been detached from its connections with the intestine was not due to a traumatic interstitial pancreatitis is proved by the normal appearance and structure of the remaining portion of the gland which had retained its anatomical and physiological relations to the intestine. I am, therefore, again supported in the assertion that physiological detachment of any portion of the pancreas is invariably followed by degeneration and complete atrophy, consequently also by complete cessation of functional activity.

Internal Pancreatic Fistula.

It is a well-known fact that when pancreatic juice is brought in contact with the skin it produces irritation, an effect which has been attributed to its digestive qualities. In all the animals where an external pancreatic fistula was established, the skin

appeared sore and macerated as far as it had been kept moist with the pancreatic juice.

Clinical observation has shown that in nearly all cases where a cyst of the pancreas was treated by the formation of a pancreatic fistula the skin around the fistula remained in an eczematous condition so long as the fistula continued to discharge fluid. Taking these facts into consideration, we should naturally anticipate that when pancreatic juice is brought in contact with the peritoneum it will produce a destructive effect upon it by its digestive properties, or it may be even followed by diffuse peritonitis.

In opposition to this reasoning, Bernard informs us that none of his animals died when he had made a pancreatic fistula, and as in these cases extravasation of pancreatic juice into the peritoneal cavity was almost inevitable, it would appear that its effects here are not so disastrous as when it acts upon the skin. Concerning this point, Heidenhain remarks:

"The animals do not suffer from this circumstance, as the duct is regenerated in spite of the wounded surface being bathed in the secretion. Nevertheless, it is difficult to explain this. Why do not the wounded and suppurating tissues undergo digestion by the pancreatic juice? The efficacy of the albumen ferment is destroyed in some way, I presume, probably by being converted into zymogen, the living tissues having the same effect on the juice as Podolinski observed, by treating the pancreatic juice with powdered zinc or yeast ferment."

As pancreatic juice, when brought in contact with the atmospheric air, may undergo rapid changes, and thus render it abnormal, experiments made with it by injecting it into the peritoneal cavity would not represent the action of normal pancreatic juice upon the peritoneum, hence the results obtained would not represent the effects of normal secretion. To determine the effect of normal pancreatic juice on the peritoneum, I resorted to the formation of an internal pancreatic fistula, so as to bring the peritoneum in contact with the normal pancreatic secretion as it escapes from the cut surface of the gland. My experiments with external pancreatic fistula had taught me that

the isolated portion of the gland continued to secrete for seventeen to twenty-six days; hence, I was convinced that if I could establish the same conditions within the peritoneal cavity, I would secure an intermittent flow of normal pancreatic juice into the peritoneal cavity for the same length of time. The operation was performed in precisely the same manner as for external fistula, except that the cut end of the duodenal portion was detached from the duodenum, turned downward, and dropped into the peritoneal cavity.

Experiment XXXIII.—Young dog; weight, 31½ pounds. Section of pancreas near middle, detached duodenal end from bowel to the extent of three inches, turned it downward, and closed the abdominal wound completely. Second day, temperature 106° F.; slight tympanites. Dog appeared quite ill for a number of days, and temperature remained above normal for a week, though the animal remained in good condition until killed, seventy-six days after the operation. The autopsy showed evidences of a former local peritonitis at the site of operation; the duodenal or detached end of pancreas was completely atrophied, its ducts dilated, closed, and adherent to duodenum. Splenic portion normal in size and appearance; cut end adherent to duodenum; common duct pervious.

Experiment XXXIV.—Adult dog; weight, 21 pounds. Detached pancreas from its middle toward distal side to the extent of five inches. Divided the pancreas with Paquelin's cautery, between two compression forceps; used no ligatures. Turned end of lower portion downward, and closed the abdominal incision. Animal died on the third day, with symptoms of peritonitis. No rise in temperature. Post-mortem examination showed evidences of diffuse purulent peritonitis; no hemorrhage, no sign of gangrene of duodenum.

Experiment XXXV.—Adult dog; weight, 37 pounds. Ligated pancreas on distal side of common duct. Divided the gland transversely just below ligature, tied vessels with catgut, detached duodenal portion from intestine to the extent of three inches, turned the free end downward, and closed the abdominal incision. Temperature remained normal, but the animal was reported sick for five days, when recovery set in, and the dog remained in good health as long as he was under observation—thirty-two days, when he ran away.

EXPERIMENT XXXVI.—Adult cat; weight, 5¼ pounds. Applied ligature below common pancreatic duct, and divided the gland on distal side of ligature, detached duodenal portion from intestine to the extent of two inches, turned the free end downward, and closed the abdominal wound. The animal remained well after the operation, and was in good condition when killed eighty-three days after the operation. Great omentum was adherent to lower border of liver; mesentery adherent to duodenum; duodenal portion of gland completely atrophied; cut extremity of splenic portion adherent to duodenum by a firm cicatrix just below the entrance of the common duct into the intestine. This portion of the gland was normal in size and appearance. Atrophied portion was abundantly supplied with blood-vessels.

EXPERIMENT XXXVII.—Adult cat; weight, 5½ pounds. Pancreas was ligated just below the common duct, transverse section of the pancreas below ligature, detached the peripheral portion to the extent of an inch and a half, turned the free end downward, and closed the abdominal incision. Death on third day. No hemorrhage into the abdominal cavity; diffuse purulent peritonitis; adhesions between the duodenum, liver, and greater omentum.

EXPERIMENT XXXVIII.—Young cat, same operation as in Experiment XXXVII. No serious symptoms were observed after the operation. About two weeks later progressive emaciation, until the animal died forty-two days after operation. At the post-mortem, an extensive abscess was found underneath the skin over the sacrum. Some evidences of previous peritonitis, but no effusion or suppuration. Duodenal or detached portion quite vascular, but in a condition of advanced atrophy. Splenic portion was normal in size and appearance, but cut end was firmly adherent to the duodenum below the entrance of the common duct.

EXPERIMENT XXXIX.—Young cat. Operation the same, followed by no serious symptoms and no rise in temperature. Animal was killed seventy days after the operation. At the autopsy, the lower border of liver was found adherent to the cicatrix of the abdominal wound. Duodenal portion was completely atrophied. At the point where the duodenum was denuded of its mesentery, the bowel had become acutely flexed by cicatricial contraction which approximated the raw surfaces. The same cicatrix connected the atrophied and intact portion of the pancreas.

Experiment XL.—Adult cat. Pancreas detached from duodenum to the extent of an inch and a half, otherwise operation same as in preceding cases. Rise in temperature on fourth and seventh day, otherwise the animal was in good condition. Killed forty-two days after the operation. Animal was well nourished. Great omentum adherent to cicatrix of wound. At the point where the gland was detached from the duodenum, the bowel doubled upon itself acutely, the raw mesenteric surfaces being in direct contact. The connective tissue remnant of the duodenal portion was incorporated in this cicatrix but could be readily identified. Cut surface of splenic end was firmly adherent to the duodenum below the entrance of the common duct; presented normal appearance in size, structure, and shape.

Experiment XLI.—Young cat. Operation the same as in preceding case. Temperature on fifth day, 105.5° F. Animal was killed on seventh day: wound not completely healed; abscess on concave side of the duodenum; no peritoneal effusion or signs of general peritonitis.

Experiment XLII.—Adult dog; weight, 13 pounds. Operation same as before, mesenteric denudation of duodenum two inches. From second to eighth day slight rise in temperature. Animal in excellent condition when killed thirty-five days after operation. Small ventral hernia. A number of adhesions at site of operation. Mesenteric circulation at point of detachment restored by a plexus of new vessels, contained in a narrow band of cicatricial tissue. Duodenal portion almost completely absorbed, only a few scattered imperfect lobules visible. Splenic end normal and in communication with duodenum through common duct.

Experiment XLIII.—Adult dog; weight, 15 pounds. Operation same as in preceding experiment. No disturbance of digestion or nutrition, and no rise in temperature. Animal was in good condition when killed thirty-five days after operation. Duodenal portion indurated and contracted into a hard string which contains a dilated duct. Liver adherent to diaphragm. Duodenum without a proper mesentery over a space of several inches, vascular supply furnished by new vessels passing along the surface of the bowel on the concave side. Examination showed that ligature had been applied on splenic side of duct, and that the section had probably been made near or through the common duct, as the splenic portion was also in a state of advanced atrophy and not in communication with the bowel. The duodenal

portion was in a state of extreme atrophy, much shortened, and firmly adherent to the bowel. Just below point of operation, a small encapsulated abscess was found on the convex side of the bowel.

In this case no pancreatic juice could gain entrance into the bowel, and yet digestion and nutrition appeared to be unimpaired.

No.	Animal.	Time of death	Cause of death.
1	Dog,	76 days,	Purulent peritonitis.
2	"	3 "	Killed.
3	"	Living,	Ran away 32d day.
4	Cat,	83 "	Killed.
5	"	3 "	Purulent peritonitis.
6	"	42 "	Abscess in sacral region.
7	"	70 "	Killed.
8	"	42 "	"
9	"	7 "	"
10	Dog,	35 "	"
11	"	35 "	"

Remarks.—As in cases of external pancreatic fistula the secretions amounted often to more than four ounces a day, we have every reason to believe that the same quantity was secreted and discharged into the peritoneal cavity in the cases in which an internal pancreatic fistula was established. The effect, if any, of the pancreatic juice upon the peritoneum can be seen best by an examination of the preceding table.

In only two of the eleven experiments was death caused by purulent peritonitis. In one a circumscribed abscess was found in the concavity of the duodenum, and in one animal a small abscess, with thick walls, was found on the convex surface of the duodenum, which did not give rise to any symptoms during life. One of the cats died from the consequences of a large abscess over the sacrum forty-two days after the operation. The post-mortem appearances in the abdomen pointed to only a very circumscribed peritonitis at the seat of operation. As the mortality after the formation of an internal pancreatic fistula did not exceed the death-rate of any other form of operation upon the pancreas, we are justified in the assertion that normal pancreatic juice when brought in contact with the peritoneum does not produce peritonitis.

Another question which presents itself is this: What becomes of the pancreatic juice in the peritoneal cavity? No mention is made in the autopsy records of these cases, of the presence of any kind of effusion in the peritoneal cavity, except in the two cases where death resulted from purulent peritonitis, when the abdomen contained a considerable quantity of a sero-purulent fluid thrown out by the inflamed serous membrane. From these evidences we can only arrive at the legitimate and logical conclusion that normal pancreatic juice is promptly and rapidly removed by absorption when brought in contact with the peritoneum. The uniformity with which the detached portion of the pancreas was found atrophied, only corroborates the statements previously made when we considered the same question in connection with external pancreatic fistula. Another incidental observation of considerable importance was made concerning the danger of gangrene of the duodenum in case the mesentery is detached to any considerable extent.

In all of these experiments the duodenum was denuded of its mesentery, and consequently deprived of its direct vascular supply to the extent of from one to three inches, and yet in no case was the duodenum found gangrenous. As in other experiments upon the pancreas, the duodenum showed a marked immunity against gangrene from interruption of its vascular supply. The last experiment is of great importance, as it illustrates that digestion may remain unimpaired even if no pancreatic juice is produced, or in the event of its secretion not gaining entrance into the intestine on account of complete and permanent obliteration of the common or principal pancreatic ducts. The ligation experiments, as well as the internal pancreatic fistula, also corroborate the statement made by some authors, that the introduction into the circulation of normal pancreatic juice is innocuous, and that this abnormal supply is tolerated for two weeks or more without any appreciable ill consequences.

V. Wounds of the Pancreas.

Of all abdominal organs the pancreas is most exempt from injury, both from direct and indirect violence, a circumstance which is entirely due to its remote location, and the ample protection furnished by the vertebral column and the bony walls of the chest. The anatomical relations of the pancreas to numerous and important organs are such that when this organ is injured the same violence which has produced the injury has also wounded an adjacent and perhaps more important viscus. The frequency with which such grave complications attend wounds of the pancreas, and the profuse hemorrhage which usually attends such injury, are elements of danger which impart to wounds of the pancreas more than an ordinary degree of gravity.

Contusion.

Case I.—Cooper (*Lancet*, Dec. 31, 1839, vol. i. p. 486) reports the case of a man, aged thirty-three years, run over by a light cart, moving with great speed. No marks of external injury were visible, but the lower left ribs were fractured, and the pancreas was literally smashed, and embedded in semi-coagulated blood. The spleen and left kidney were also ruptured. He died a few days after the accident.

Case II.—Travers (*Lancet*, 1827, vol. xii. p. 384) observed a case of laceration of the pancreas at St. Thomas's Hospital. An intoxicated woman was knocked down by the wheel of a stage-coach, which, however, did not pass over her. She lived only a few hours. Several ribs were fractured; the pancreas was found completely torn through transversely, the liver was lacerated, and much blood was effused.

Case III.—Störck (*Annus Medicus*, 1836, p. 244) mentions the case of a woman who was run over by a coach, and who died within a few hours. The pancreas was found completely torn in two, and embedded in a large mass of semifluid blood. Several ribs were fractured, and the liver was also ruptured.

Case IV.—M. Le Gros Clark (*Lect. on Princ. Surg. Diag.*, 1870, p. 298) observed an instance of subcutaneous laceration of the pancreas,

which occurred in a lad who was also the subject of other severe injuries that speedily proved fatal.

Penetrating Wound of Abdomen, with Protrusion of Pancreas.

Case V.—Laborderie (*Gazette des Hôpitaux*, 1856, No. 2) reports the case of a girl, aged ten years, who had fallen, while running, upon an open pocket-knife, which inflicted a wound two centimetres below the lower border of the rib, and three fingers' breadth to the right of the median line, extending outward for one and a half centimetres, almost horizontal, with a little inclination from above downward. The pancreas was found strangulated in the wound so tightly that not a drop of blood escaped. The author believed that the prolapse was caused by the screaming of the patient. The duct of Wirsung and vessels escaped injury. The abdomen was painless on palpation, and there were no signs of internal hemorrhage. The knife had entered the abdomen under the lobus Spigelii of the liver, and in its course reached the stomach, cut through the gastrohepatic omentum, and then penetrated between the liver and pylorus to the pancreas, without injuring any of the many large vessels in the locality through which it passed. An attempt to replace the gland was only partially successful. The mass was transfixed and tied at its base with a double ligature, and the portion outside of the ligature removed with the knife. After this procedure nausea and vomiting set in, which, however, soon subsided. The wound was treated by the use of cold water applications. On third day the patient complained of being chilly, and the abdomen became somewhat tympanitic and tender on pressure. These symptoms soon subsided, and the ligatures sloughed through, leaving a granulating surface, which healed in fourteen days. Recovery was complete in three weeks.

Hyrtl and Klebs are incredulous as to the prolapse of the pancreas in this case; they believe that the mass which was ligated and removed was not the gland, but a portion of the omentum. Nussbaum (*Die Verletzungen des Unterleibes*, 1880), however, in speaking of visceral injuries of the pancreas, states distinctly that in penetrating wounds of the abdomen in the region of the pancreas, this organ manifests a tendency to

prolapse, and that this circumstance facilitates the treatment, as it protects the peritoneal cavity against infection by plugging the wound, and at the same time affords better access to the bleeding vessels.

Case VI.—Dargau (*Medical and Surgical Reporter*, Aug. 22, 1874) saw a case in which the pancreas protruded through a wound five inches in length, between the last two false ribs, on the left side. The patient was a negro, who had been injured fourteen hours before he came under treatment. The pancreas was replaced, the wound closed, and the patient made a good recovery.

Case VII.—Caldwell (*Transylvania Journal of Medicine*, 1828, vol. i. p. 116) reports the following remarkable case. In 1816, a negro was stabbed in the left side, and "an oblong body, between three and four inches in length, was observed to have protruded." Drs. Roberts, Heard, and Caldwell supposed the protruded part might be mesentery, omentum, or lung substance; but, on a more minute examination, that opinion was changed to the belief that it was the small extremity of the pancreas. The protruding part was in a gangrenous condition, and was removed with the knife. The patient soon recovered. The gentlemen who treated the case, "thinking it almost impossible that the pancreas could escape through a part of the diaphragm and between the ribs," made a critical examination of the part removed, which resulted in their *thorough conviction* that the tissue removed was a portion of the pancreas.

Case VIII.—Kleberg, who, together with Dr. Wagner, Jr., examined the specimen of pancreas microscopically at the time, reports in Langenbeck's *Archiv für Chirurgie*, vol. ix. p. 523, the following case:

A. S., æt. sixty, a discharged soldier, of powerful frame, and a drinker, was surprised while burglarizing and cut in the abdomen with a knife from below upward while stooping over. He was carried into the surgical wards of the hospital at 6 A. M., having a cut in the abdomen running horizontally about twelve inches in length, between the navel and lower border of the ribs on the right side. Protruding from the wound was a brown-red body about three inches long by two inches in width, of a doughy consistence and covered by a smooth membrane. Immediately after entering the hospital he had a normal passage through the bowels; pulse 72; no pain. The stomach, intestines, and liver

could be excluded on examining the appearance and physical properties of the projecting body. There was no fat, as would have been the case had it been the omentum of such a corpulent person. The prolapsed body was compact and homogeneous, could not be separated into layers, and presented no dilated vessels. It was, therefore, taken to be the head of the pancreas.

Treatment: As reposition of the protruding part did not appear advisable, on account of a possible constriction, and as the consequences could not be foreseen, the part was fixed in the wound with two Karlsbad needles, which were passed through the sides of the wound and the protruding part; a silk ligature was then passed around the pedicle of the protruding part and the end cut off with one stroke of the knife; the profuse oozing of blood was stopped by tightening the ligature. The stump was touched with liq. ferri sesquichlor., and cold applications made over the whole abdomen. There was no fever, peritonitis, or disturbance of digestion in the course of the recovery. The needles and sutures were removed on the fourth day; the stump had become adherent to the edges of the wound. The stump and ligature came away on the tenth day. The patient left the hospital twenty days after admission, with a three-cornered depressed scar. As he was perfectly well nourished during the entire time, it is probable that the caudal extremity of the gland was removed and that the portion of the gland remaining, with the excretory duct, performed the functions of the gland adequately.

The following two cases are from the *Medical and Surgical History of the War of the Rebellion*, Part II. Vol. II., Surgical History, p. 158.

Case IX.—Assistant Surgeon J. G. Thompson, 77th New York, reports the case of "a soldier, name unknown, who was wounded at Cedar Creek, October 19, 1864. The ball entered the right side, below the ribs, and emerged on the left side. He was removed to the Taylor Hospital, at Winchester. While straining at stool, two days subsequently, a hernia of the pancreas occurred of the size of a hen's egg. A silver wire was passed about the pedicle by which it was attached, and twisted tighter each day for about a week, until it became very small, and was snipped off with scissors. No especial symptoms supervened, and by the last of November the patient was in a fair way

toward recovery, and was moving about the hospital. In December he was still doing well."

Case X.—Private William Freshwater, Co. F., 66th Ohio, received wounds of the abdomen, left forearm, and neck, at Port Republic, June 9, 1862. He was conveyed to Front Royal, arriving on the 13th, and on the 14th was sent by rail to Washington, and admitted, on the 15th, to Judiciary Square Hospital. He was placed in a ward under the charge of Acting Surgeon D. W. Cheever, who states that "a ball had entered one and a half inches outside the left nipple, on a level with the seventh rib, and could be felt under the skin near the spinous process of the left dorsal vertebra. Some viscus, thought to be the lower tip of the lung, protruded at the wound. He died in two days (June 17th) with symptoms of peritonitis. Post-mortem: The ball had pierced the diaphragm without touching the lower lobe of the lung; there was no perforation of the intestines, but they were glued together by peritoneal inflammation. The pancreas protruded at the wound."

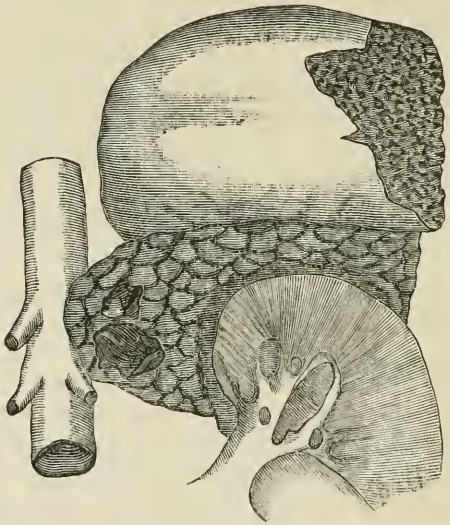
Gunshot Wounds.

The only cases of gunshot wounds of the pancreas that I have been able to find are reported by Otis (*Ibid.*, p. 159).

Case XI.—Private J. Koprieau, Co. B., 51st New York, aged thirty-two years, was severely wounded at the battle of the Wilderness, May 5, 1864, and was at once taken to the field hospital of the 2d division, Ninth Corps. As the patient could not talk English, the history of the case is quite imperfect. Assistant Surgeon J. C. McKer furnished the following description, which I have abbreviated without omitting essential facts. The patient came under his care May 25, 1864, when it was ascertained that he was suffering from a gunshot wound of the back, the ball entering about six inches to the left of the spinal column, having pushed below the eighth or ninth rib. It was evident that the ball had entered the abdominal cavity, but its course could not be ascertained. Patient's general health was apparently good, and he seemed to suffer but little pain from the injury. Appetite good, bowels regular, urine slightly suppressed and somewhat highly colored. Pulse normally full, but slightly irritable. The patient was ordered quinine, whiskey, nourishing diet, and two doses of acetate of potassa. No noticeable change appeared for about one week, when a severe hemor-

rhage occurred, apparently venous, from the external wound, which was soon arrested by the use of compresses and styptics. About six hours afterward a quantity of urine was voided, which was thickly mixed with blood. These hemorrhages continued to recur two, three, and four times daily till death, the urinal discharge being very frequent, and always bloody. Death resulted June 5, 1864. Post-mortem examination revealed the following: A Minie-ball entered at the middle portion of the eighth rib, fracturing the same, passed through the centre of the spleen toward the pancreas, penetrating this also in a nearly

FIG. 21.



A WET PREPARATION OF PORTIONS OF SPLEEN, PANCREAS, KIDNEY, AND CŒLIAC AXIS, SHOWING MUSKET-BALL EMBEDDED IN THE PANCREAS.
Specimen, Army Medical Museum, No. 2430.

transverse direction, and (probably a few days before death) sinking toward the splenic artery, tearing it, and lodged at its origin from the cœliac axis; the lung was found emphysematous. The ball was found embedded in the pancreas in a pouch between the sloughing artery and vein. The specimen is preserved as a wet preparation in the Army Medical Museum, and is marked No. 2430. (Fig. 21.)

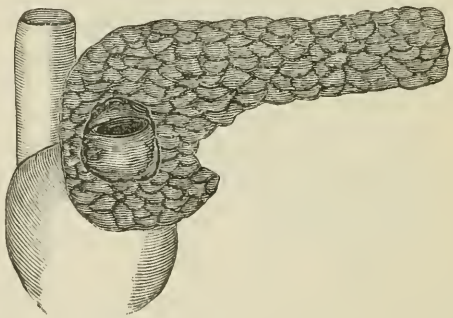
CASE XII.—Corporal A. B. Jones, Co. D., 5th Vermont, aged twenty-seven years, was wounded at the battle of the Wilderness, May 10,

1864, and laid on the battlefield one day and night; was then removed to the field hospital, from there carried by boat to Washington and jolted over a rough road of two miles to the Lincoln Hospital, which he reached about two o'clock in the morning of the 25th. Was seen a few hours afterward by Acting Assistant Surgeon T. L. Leavitt, who found him suffering great agony. On examination it was found that the ball had entered one line to the left and below the ensiform cartilage, passing through the abdominal cavity and making its appearance under the skin just above the crest of the ilium posteriorly, where it was excised at the field hospital. Pulse quick and exceedingly feeble, abdomen distended and tympanitic. Opium was administered and the patient took liquid food freely. About noon of the same day the symptoms improved, wound suppurating nicely. About four o'clock was conversing with nurse, apparently in good spirits, without very great pain; in about five minutes afterward was *in articulo mortis*. The autopsy showed the ball to have perforated the inferior curvature of the stomach, and, strange as it may seem, although an orifice was made directly through the walls of the stomach large enough readily to admit two fingers, no inflammation or even congestion could be detected, except in the immediate locality of the wound, which was beginning to suppurate. Evidently the stomach was also uninjured in its functional capacity, as was witnessed by the reception and digestion of food during life. Some branches of the gastric artery were severed, and about an ounce and a half of dark uncoagulated blood was found. The pancreas was perforated at about its middle, but, except in the immediate track of the ball, gave evidence of no departure from its healthy standard; the intestine and colon were pushed aside during the passage of the ball and were uninjured; the omentum was found in a state of partial decomposition and closely adherent to the small intestine. Liver and spleen healthy. General peritonitis had prevailed and was undoubtedly the cause of death. In this case life was sustained for a period of fifteen days, notwithstanding the serious injury of a vital organ and the exposure to the most unfavorable circumstances and depressing influences.

Case XIII.—Private William P. B., Co. A., 44th Georgia, was wounded near Fort Stevens, in General Early's demonstration on Washington, July 12, 1864, by a cylindrico-conical musket-ball, which entered below the spine of the left scapula, an inch from the shoulder-joint, and penetrated the chest. He remained a prisoner on the field,

and was conveyed to Lincoln Hospital, a few miles distant, being admitted on July 14th. He was examined by Dr. Leavitt, who found that emphysema extended over the entire left chest, that respiration was painful, but not otherwise difficult, and that there was paralysis of motion of the left arm. There was little change in the progress of the case until the 18th, when the pain in the side became severe, and was somewhat relieved by sinapisms. Following day, dulness over posterior left chest, also extreme dulness in the præcordial region and the heart was forced over to the right side. There was dulness too at the base of the right lung, with indistinct respiratory murmur. On the 20th, jaundice was very pronounced. On the 21st, profuse hemorrhage from the nose and mouth occurred, bleeding coming apparently from the lung. Pulse at this time very weak and thready; jaundice extreme. On the 22d there was much pain in the left side, dyspnœa, consciousness perfect, pulse failing; death at noon, July 24, 1864, twelve days after the injury. At the autopsy the wound was traced from the entrance in the scapula through the fractured fifth rib, the track

FIG. 22.



PANCREAS WITH A CONOIDAL MUSKET-BALL EMBEDDED IN ITS HEAD.
Specimen, Army Medical Museum, No. 2884.

passing downward, inward, and backward, through the lower lobe of the left lung, the diaphragm, the left lobe of the liver to the head of the pancreas, where the ball was found lodged in the head of the viscus, at the angle formed by the cœliac axis with the aorta. The lower lobe of the right lung was hepatized; the left lung carnified, collapsed, and compressed by a large accumulation of black fluid blood. The pancreas was rather large—seven inches long; weight, with ball, five ounces. There was nothing abnormal in its appearance,

except the presence of the foreign body. On examining the pancreas microscopically no deviation from the normal structure was found in sections made from the tissue taken from the left end or tail of the viscus and from the middle part. In close contiguity to the ball is a fine network of fibrillated tissue. As hardened in alcohol the specimen offers no indication of vascular engorgement having existed. The specimen is preserved in the Army Medical Museum, and is marked No. 2884. (Fig. 22.)

Remarks.—Not in a single instance of the thirteen cases of injury of the pancreas, as reported above, did symptoms during life first point to this organ as the seat of lesion. In all cases where the result was fatal, death was not attributable to the visceral lesion of the pancreas, but was always referable to injury of some adjacent organ. With the exception of cases of prolapse of this organ through a penetrating wound of the abdomen, the diagnosis and treatment of injuries of the pancreas will come under the observation of surgeons only in an incidental manner in the treatment of more tangible and graver lesions within the abdominal cavity. Contusion and laceration of the pancreas as independent conditions are not necessarily fatal injuries, and spontaneous recovery may take place, followed by absorption of the crushed portion of the organ, and atrophy of that portion of the gland which has become physiologically detached from the intestinal tract by the injury or its direct consequences. Crushing of the pancreas is usually not attended by hemorrhage, and in laceration of the organ the danger from this source is much less than in cases of incised wounds.

As modern surgery dictates not only the justifiability but the absolute necessity of treating penetrating wounds of the abdomen, where visceral injury is suspected, by abdominal section, the surgery of the future will undoubtedly deal with contusions and lacerations of the pancreas in connection with visceral injury of some of its adjacent organs. If, in exploring for injuries in this region, the pancreas should be found extensively crushed, it would be good surgery to remove the crushed portion after preliminary ligation of the organ on each side of the comminuted portion. Ligation of the pancreas can be safely done with

a single catgut or silk ligature, as the friable texture of the organ will permit of burying the ligature deeply, a circumstance which will guard against slipping of the ligature. In not a single instance where this method of ligation was resorted to in the experiments on animals, was secondary hemorrhage observed from inefficiency of the ligature. If the pancreas is lacerated, each end of the organ should be ligated for the purpose of arresting or preventing hemorrhage, as well as to guard against extravasation of pancreatic juice into the abdominal cavity.

The results obtained by experiments on animals, as detailed before, have demonstrated in a satisfactory manner that normal pancreatic juice when brought in contact with the peritoneum does not produce inflammation, but is promptly removed by absorption. In the experimental work we always had the advantage of dealing with a normal serous surface, the absorption capacity of which had not been impaired by antecedent pathological conditions, as would in all probability be the case in the operative treatment of injuries of the pancreas. At the same time there can be no doubt that the presence of crushed pancreatic tissue and pancreatic juice in the peritoneal cavity, after abdominal section, would greatly enhance the danger of traumatic infection. For this reason, if for no other, the former should be removed and the escape of the latter prevented by ligation of the pancreas on the side, or each side, of the crushed or lacerated portion.

The cases of protrusion of the pancreas seem to establish the fact that a portion of this viscus may be separated by violence from the splenic artery and other important attachments, and may prolapse through an external wound, and under such circumstances can be removed without hazardous consequences. In most cases the prolapse followed some time after the injury from a sudden increase of intra-abdominal pressure, as coughing or straining at stool. Klebs and Hyrtl's objection to the possibility of a hernia of the pancreas, can find a plausible support only by assuming that the relations of the pancreas have not been disturbed. If, by the violence which produced the penetrating wound, the attachments of the organ are severed, or in

case the attachments have been abnormally loose, or the duodenum is supplied with a long mesentery, there is no tenable reason why the pancreas should not occasionally be found protruding through the external wound. Cases are on record where the pancreas constituted one of the contents of a diaphragmatic hernia, and an instance is reported where it formed a part of the intussusceptum in a case of invagination of the bowel (Bandl).

The treatment of prolapse of the pancreas will depend upon the pathological condition of the viscus at the time the patient comes under the care of the surgeon. If the prolapse is recent and the organ presents no indication of inflammatory or other changes, it should be thoroughly disinfected and replaced. It is of the greatest importance not to resort to violence in effecting reduction, as irreparable damage may be inflicted by resorting to more than the gentlest force. When reduction is not readily accomplished, the wound should be enlarged. If the pancreas is in a condition of inflammation or gangrene, the parts should be thoroughly disinfected and the organ pulled further into the wound until healthy tissue is reached, when a ligature is applied and the diseased portion removed with the knife or scissors. After another thorough disinfection the stump is dropped into the abdominal cavity and the external wound closed. Thorough primary removal of infected tissue is the only safety against subsequent extension of the infection to the peritoneal cavity, and the only guarantee for primary union of the abdominal wound.

In gunshot wounds of the pancreas we have no guiding symptoms upon which to base even a probable diagnosis. The point of entrance and exit of the ball, and its probable course, are the only facts which may point to the pancreas as one of the injured organs. In four of the five cases the projectile penetrated posteriorly in the space between the angle of the left scapula and the angles of the ribs, and passed through the diaphragm and the solar plexus; in one, the ball entered anteriorly near the tip of the xiphoid cartilage, and was believed to have passed through the stomach.

It is a notable and somewhat significant fact, that in all cases

where life was prolonged for more than twelve days, the pancreas appeared to have undergone but little or no pathological change in the vicinity of the visceral wound. Although in all cases the track of the ball did not remain aseptic, the inflammatory changes did not materially affect the parenchyma of the gland.

In Case XIII. the formation of a capsule around the bullet had already been initiated, and if the patient had lived there is every reason to believe that the foreign body would have become encysted in the parenchyma of the pancreas. Gunshot injuries of the pancreas, when they come under the observation of the surgeon as an independent lesion, or as a complication of other visceral injuries in cases of penetrating wounds of the abdomen treated by laparotomy, should be treated in the same way as a contusion or laceration of the gland. The results obtained by the experiments have shown that if only a comparatively small portion of the pancreas remains in physiological connection with the duodenum, this portion of the gland retains its normal structure and its physiological function, which, in all of the experimental cases, was found adequate to supply the requisite quantity of pancreatic juice necessary for the maintenance of normal digestion. While the surgeon may unhesitatingly remove the tail and a portion of the body of the pancreas without fear of any immediate or remote ill effects, great care must be exercised in operating in the vicinity of the head of the pancreas to preserve the integrity of the common duct, and as much of this portion of the organ as may appear compatible with the condition which necessitated the operation.

The results of the experiments made with a view to ascertain how much of the mesentery of the duodenum can be detached without causing gangrene of the bowel have been such as to encourage a conservative plan of treatment when operating in close proximity to the intestine. The observations made in this direction have shown that it is comparatively safe to detach a portion of the mesentery even to the extent of one to three inches, a procedure incomparably easier and much safer than enterectomy combined with partial excision of the head of the

pancreas. I wish again to emphasize the fact that complete extirpation of the head of the pancreas with the common duct is never justifiable, and that operations upon this portion of the gland for injury or disease must be limited to partial excision of the head, with preservation of the common duct.

VI. Acute Pancreatitis.

Acute idiopathic pancreatitis is an exceedingly rare affection; only a few well-authenticated cases of the disease have been reported. A brief consideration of this affection is necessary in connection with our subject for the purpose of calling attention to a few of the most constant and prominent symptoms which characterize the disease, inasmuch as all suppurative lesions of this organ, which are of special interest to the surgeon, are preceded by inflammation. The disease originates either primarily in the inter-acinous connective tissue of the organ as a pancreatitis, or it occurs as a secondary disease from extension of a peripancreatitis to the substance of the gland. Haller and Klob have given an accurate clinical description of a case observed at the Allgemeine Krankenhaus in Vienna, with a careful account of the post-mortem appearances (Schmidt's *Jahrbücher*, 1860, vol. i. p. 306).

Case I.—A gilder, sixty-three years of age, had been suffering from indigestion, which was referred to a defective stomach digestion. Flatulency and vomiting were prominent symptoms. The patient was anæmic, and presented a cachectic appearance; tongue slightly coated, anorexia, epigastrium tympanitic and tender to pressure. Vomiting of a thin, yellow, bitter fluid. Slight elevation of temperature; pulse 90; lower extremities œdematous. The same evening vomiting, collapse, and great pain in epigastrium, extending over the abdomen. During the night obstinate vomiting, traces of blood in the ejected matter; urine dark colored, contained no albumen. Next day vomiting ceased, but collapse increased, followed by death toward evening. The autopsy revealed serous infiltration of gray matter of brain and lungs. The stomach was collapsed, its mucous membrane bulging. The pos-

terior wall of the stomach was perforated in three places, the openings being as large as a pea, and funnel shaped, with the larger extremity directed toward the peritoneal surface. The edges of these perforations were quite friable, discolored, and continuous with a fetid abscess cavity, which extended from the posterior surface of stomach to the spinal column, and from the spleen to the pylorus, in which the pancreas was found as a grayish, discolored, flabby, thin, and exceedingly fragile mass infiltrated with pus. In front of the anterior wall a fringed portion of the bursa omentalis was found, and on the upper border the arteria and vena lienales were seen; the latter was filled with a thrombus. Examined under the microscope the parenchyma of the gland showed that the cells were degenerated, being distended and turbid; acini separated, at some places collapsed, and the spaces between them contained granules and large globules of fat.

In this case the course of the disease was quite acute, terminating in diffuse suppuration, and death after an illness lasting only sixteen days. The absence of disease in any of the adjacent organs, and the advanced pathological changes in the gland, pointed to the pancreas as the primary starting-point of the inflammation.

Case II.—Mayo (*Outlines of Human Pathology*, London, 1836, p. 409) also gives an interesting description of a fatal case of subacute pancreatitis, with the post-mortem appearances. The patient was a lady, twenty-one years of age; when five months advanced in pregnancy she lost her usual healthy appearance, and gradually became very anæmic. She complained of great thirst, and also suffered much from pain in the epigastric region, which was sometimes so severe as to oblige her to retire to her apartment. After her delivery the thirst remained, and the weakness and paleness increased. Her state and symptoms were like those of persons who have lost large quantities of blood. About five days before death the stomach became irritable, and nothing but rennet-whey in small quantities was retained. She died five weeks after delivery. Upon inspecting the body the viscera generally were found pale and bloodless. Besides serous effusion on the membranes of the brain and the abdominal organs no pathological changes were observed, except that the pancreas was throughout of a deep and dull red color, which contrasted very remarkably with the

bloodless condition of other parts. It was firm to the touch externally; and when an incision was made into it the divided lobules felt particularly firm and crisp.

Case III.—Haidlen (*Centralblatt für Gynäkologie*, Sept. 29, 1884) reports the following case from Fehling's private practice. A woman, aged thirty-three years, became pregnant, and during the period of gestation had considerable gastric disturbance and headache. She remained well three weeks after delivery, when there was some hemorrhage. A little later she had two attacks of pain in the region of the stomach, and five and a half weeks after delivery she had a very severe attack of pain in the pyloric region, accompanied by vomiting. There was no elevation of temperature, the pulse was 100 to 104, and regular. The epigastric region was sensitive to pressure, but there were no symptoms of peritonitis, the skin was pale and not jaundiced. The patient seemed somewhat collapsed. In the afternoon of that day she seemed worse, the skin was paler, the pulse more rapid, and the vomiting had ceased. Physical examination showed marked swelling of the abdomen, and great tenderness over pyloric region. No pelvic disturbances. On the following day the patient was better, but the symptoms returned, and she died, in collapse, in ninety-six hours. The autopsy showed that there was no peritonitis, though a small amount of a dirty, bloody-looking fluid was found in the lower part of the peritoneal cavity. The organs, with the exception of the pancreas, were normal. The pancreas had undergone considerable changes: it was larger, thicker, and broader than normal, and in only a few places was its normal color retained; it had changed almost entirely to a brownish-red, blood-suffused mass, containing a small clot of blood on the anterior surface, in contact with the mesentery, but there was no perforation anywhere. The adjacent portion of the mesentery was suffused with blood. Ziegler, who made the microscopic examination, pronounced the case one of acute pancreatitis, and stated that the duct of Wirsung was somewhat dilated, and that he also found small-celled infiltration of the pancreatic tissue.

Remarks.—The immunity of the pancreas from disease is attributed by Gross to the singular structure of this organ, to its concealed situation, and to the absence of everything like a proper envelope. (*Elements of Pathological Anatomy*, Philadelphia, 1857.)

The first two cases may serve as types of the two distinct forms of inflammation of the connective tissue of the pancreas, the suppurative and interstitial. Another form, the parenchymatous variety, is occasionally met with in the puerperal state, in cases of typhoid fever, pyæmia, yellow fever, and other acute infectious diseases, the post-mortem appearances of which are illustrated by Case III. In this form the pancreas is red, swollen, and œdematous. Microscopically in this variety the most prominent lesion consists in swelling and undue granulation of the glandular epithelium and hyperæmia. (Delafield and Prudden, *Pathol. Anatomy and Histology*, New York, 1885, p. 369.)

In the first case the symptoms were acute, and the disease terminated in death in the short space of sixteen days. The suppurative inflammation beginning in the interstitial tissue involved the entire gland, and extended by continuity to the para- and peri-pancreatic tissue, giving rise to a diffuse and acute abscess. The termination is sufficient evidence that the inflammation was produced by a specific cause—the pus microbes. In the second case the primary seat of the inflammation was the same, but the process assumed a subacute character, and terminated in a hyperplasia of the connective tissue. The most prominent symptoms in both cases were severe pain in the epigastrium, progressive anæmia, and vomiting. In both cases the pain assumed a neuralgic character. The pain was referred to the region of the cœliac plexus, radiating from there over the abdomen. Neuralgia of the cœliac plexus is one of the most constant symptoms of disease of the pancreas, as Klebs alludes to it as being present eleven times in fifteen uncomplicated cases. Atrophy of the cœliac plexus is mentioned by Klebs as the cause of the neuralgia.

A high degree of anæmia was apparent in both cases from the extensive area of tissue which was found in an œdematous condition, as well as from the statement of Mayo, that his patient presented the appearance of a person who had suffered from repeated and severe hemorrhages. As the pancreas is not concerned directly in the function of hæmatogenesis, we can only explain the constancy with which this symptom is mentioned,

by assuming that the anæmia was due to imperfect digestion and assimilation, caused by an arrest of pancreatic secretion. Vomiting was an early and troublesome symptom in the first case, but appeared only toward the close of the disease in the second case. No reference is made to the condition of the stools in either case. The presence of undigested fat in the stools is, however, one of the rare symptoms of disease of the pancreas. Klebs states that in three cases where this symptom was present, the ductus Wirsungiani was either entirely or partially obliterated, while in a number of cases where the duct was in the same condition the stools remained normal.

VII. Chronic Interstitial Pancreatitis, or Sclerosis of the Pancreas.

This lesion consists in an increase of interstitial connective tissue which may affect the entire organ or remain limited to some particular portion, more especially the head of the gland. During the early stages of the disease the organ is enlarged, more vascular and firm, while later the cicatricial contraction of the interstitial deposit produces atrophy of the parenchyma, with a corresponding diminution in the size of the organ. This form of inflammation of the pancreas is of particular interest to the surgeon, as the cicatricial contraction may produce secondary changes in the pancreatic or bile-ducts, an occurrence which would indicate a resort to surgical measures for the relief of immediate symptoms due to retention of the secretions.

The causes which produce sclerosis are often obscure, but usually referable to some antecedent affection in some of the adjacent organs of the pancreas, as the peritoneum, subperitoneal tissue, duodenum, the common bile-duct, or pancreatic lithiasis, where the primary cause is in the pancreas itself. The connective tissue proliferation destroys the parenchyma by compression and constitutes one of the causes of stenosis of the pancreatic duct.

Case I.—Todd (*Dublin Hospital Reports*, vol. i.) observed this condition in a girl fourteen years of age, in whom the head of the pancreas and the neighboring connective tissue were the seat of the disease. This case is of unusual interest, as the contraction of the cicatricial tissue produced obstruction of the common bile-duct by compression, which caused a dilatation of the bile-ducts behind the seat of obstruction, converting them into a large sac, which was located behind the duodenum and reached downward as far as the sacrum and laterally from one kidney to the other.

Case II.—O. Wyss (Virchow and Hirsch's *Jahresbericht*) gives a description of another case in point. A man, fifty years of age, became deeply jaundiced and had three or four loose, clay-colored stools daily. He died after an illness of four and a half months' duration. At the autopsy the liver was found enlarged and of a deep olive-green color. Gall-bladder and bile-ducts were much dilated and contained inspissated bile. The common bile-duct entered the head of the pancreas four centimetres before its termination in the duodenum and traversed the indurated portion of the organ for a distance of two and a half centimetres. At this point the duct was found so much contracted that only a fine probe could be passed through it. The common pancreatic duct was dilated, also its branches, which at some points were dilated in the form of cysts, varying in size from that of a hempseed to that of a hazelnut. Wyss attributed dilatation of the common duct to compression by one of the smaller cysts in the head of the pancreas, but it is more than probable that the dilatation was due to the cirrhotic contraction of the organ.

That icterus is not a constant symptom of this condition is illustrated by the following case, reported by Claessen:

Case III.—A man, thirty years of age, had been subject to indigestion, constipation, and severe pain in the epigastrium for several years. After his death it was shown at the autopsy that the head of the pancreas and the acini were yellow, and the inter-acinous connective tissue abundant, and yet the duct of Wirsung and the bile-duct were not contracted.

Remarks.—The surgical treatment of sclerosis of the pancreas can only apply to secondary lesions which result from stenosis

of the pancreatic or bile-ducts and distention of these passages by accumulation of the secretions. Such an occurrence is most apt to take place when the disease affects the head of the pancreas, as the cicatricial contraction in this locality may cause stenosis of either the duct of Wirsung, the common bile-duct, or both. Any operative interference in these cases will be of necessity limited to an attempt to secure an artificial outlet to the retained secretion. The restoration of the permeability of the natural outlet by any method of treatment is entirely out of question.

The tendency of the disease is to aggravate the obstruction as cicatricial contraction progresses. The history of all these cases pointed to an impairment of digestion as the principal clinical feature in each instance. It is, therefore, of considerable importance to examine carefully into every obstinate and obscure case of indigestion, with a view to eliminate the possibility of organic disease of the pancreas as the cause of the derangement of digestion. In cases of permanent retention of the bile or the pancreatic juice caused by cicatricial compression of the bile-duct or the pancreatic duct, the earlier symptoms will have reference to a history of obstinate indigestion, progressive in its character. If, on the other hand, the obstruction is produced by the impaction of a calculus, the previous history points to attacks of sudden and severe pain and other symptoms indicative of the passage of a calculus along the excretory duct.

In case of biliary retention cysts, as represented in Case I., the establishment of an external biliary fistula would result in a permanent fistula, as the impermeability of the bile-duct would preclude the possibility of reëstablishing, by any kind of an attempt, the normal communication between the dilated bile passages and the intestine. Such an operation would remove only the urgent symptoms due to retention and absorption of bile, but would leave unchanged the primary cause of the retention and would exclude, permanently, the bile as a digestive fluid from the alimentary canal. As the obstruction is permanent and irremediable, the operation which suggests itself as fulfilling the urgent indications, as well as preventing remote ill

consequences, is the formation of a new outlet for the bile into the intestinal canal, by establishing a permanent fistula between the duodenum and the gall-bladder, or between the duodenum and the dilated bile-ducts. Duodeno-cholecystostomy has a future in all cases of permanent and incurable obstructive lesions in the bile-duct, and will become an established operation as soon as it has been perfected by an improved technique.

My experiments on animals have demonstrated that physiological detachment of any portion of the pancreas is invariably followed by degeneration and atrophy, irrespective of the particular method by which this detachment is effected; consequently it is only reasonable to assume that permanent obliteration of the pancreatic duct by cicatricial contraction is always followed by degeneration of the parenchyma of the gland on the distal side of the seat of obstruction.

It is on this account that stenosis of the pancreatic duct is seldom followed by dilatation of the ducts to any considerable extent on the distal side of the constriction, and even more seldom by the formation of a cyst. A retention cyst can result from obstruction only so long as secretion has not been entirely suspended, and when, at the same time, absorption of the pancreatic juice does not take place on account of further extensive pathological changes in the structures which perform this function when the gland is otherwise in a normal condition.

As the physiological detachment by obstruction of the common pancreatic duct caused by cicatricial contraction is invariably followed by complete destruction of the parenchyma of the contributory portion of the gland, it is evident that the surgical treatment of a cyst of the pancreas in such cases can be indicated only when the swelling becomes, in itself, a source of serious inconvenience and pain. The proper treatment in all such cases consists in the formation of an external pancreatic fistula by abdominal section. There is no danger, in such instances, of the fistula remaining permanent, as the glandular tissue which might remain at the time of operation will, in the course of time, disappear by degeneration and absorption. As in animals, so in man, the health of the individual after gradual atrophy of the

pancreas will depend upon the physiological capacity of vicarious organs, in each particular case, to assume the functions of the pancreas.

In recapitulation, it may be stated that cirrhosis or chronic interstitial pancreatitis sometimes produces stenosis of the bile-duct or the pancreatic duct, and that, when the obstruction is followed by retention of the secretions, an operation becomes always necessary in biliary retention, which should be treated by establishing a new outlet for the bile into the duodenum, while the formation of an external pancreatic fistula in cases of cyst of the pancreas becomes necessary only when the presence of the swelling in itself has become a source of sufficient pain and discomfort to warrant treatment by abdominal section.

VIII. Gangrene of the Pancreas.

One of the terminations of acute inflammation of the pancreas is gangrene. Cases have been reported where spontaneous recovery followed elimination of the necrosed organ through the alimentary canal. If spontaneous recovery in this condition is possible, it would seem plausible that a timely removal of the necrosed organ by surgical interference would add to the chances of recovery, consequently we shall add gangrene as one of the diseases of the pancreas which should be treated by operative measures.

Case I.—Trafoyer, of Hernals, treated a patient suffering from what appeared to be a passage of gall-stones. During the course of the disease the patient passed, per rectum, a solid mass, the nature of which could not be readily ascertained. This mass was sent for examination to Rokitansky, who found in it gall-stones and a large part of the pancreas in which the duct was plainly visible. Rokitansky believed that a portion of the pancreas had become invaginated into the duodenum and had sloughed. Nothing could be ascertained concerning the subsequent history of the case. (*Allgem. Wiener Zeitung*, No. 29, 1862.)

Case II.—Reported by Chiari (*Wiener med. Wochenschrift*, Nos. 6 and 7, 1881). Female, aged forty-six years, who had been subject to occasional attacks of pain in the stomach. She was seized suddenly with severe pain in the abdomen, followed by vomiting and other symptoms of diffuse peritonitis. Toward the close of the disease she had a chill, and vomited a black, very offensive fluid. At the necropsy the pancreas was found separated from all its attachments and of a brownish color. The duodenum and transverse mesocolon were perforated, the bursa omentalis contained an offensive sanious fluid, consecutive to diffuse peritonitis. The pancreatico-duodenal artery was eroded.

Case III.—(*Ibid.*) Patient, a man thirty-eight years of age, was attacked with symptoms indicative of cholelithiasis, followed by symptoms of obstruction of the bowels which lasted for a number of days, and subsided only after the passage, per rectum, of the greater portion of the necrosed pancreas. The patient recovered.

Case IV.—Israel reports a case of necrosis of the pancreas in a patient suffering from diabetes mellitus. (Virchow's *Archiv*, vol. lxxxiii. p. 181.) The autopsy showed a fluctuating tumor between the stomach and transverse colon which revealed itself as a cyst, with thick walls firmly adherent to the intact head of the pancreas. The cyst contained 300 cubic centimetres of a clay-colored fluid, in which crystals of hæmatoidin were found, and the necrosed body and tail of the pancreas. Israel attributes the cause of the destructive process to an inflammation of the peripancreatic tissue, which had given rise to repeated hemorrhages into and around the pancreas. The disease of the pancreas, he holds, was not the cause, but the effect of the diabetes.

Case V.—Prince ("Pancreatic Apoplexy, with a Report of Two Cases," *Boston Med. and Surg. Journ.*, July 13 and 20, 1883) reports the following case: A man, twenty-two years of age, during a violent exertion, was taken with severe pain in the abdomen, followed by pain in the epigastric region, vomiting, chills, and a sensation of great oppression and uneasiness. In a few days diarrhœa followed, and during the third week he died. At the autopsy the anterior abdominal wall was found firmly adherent to the omentum and intestines; between the intestinal convolutions a chocolate-colored fluid was found. The greater portion of the pancreas was destroyed and converted into a

black gangrenous mass. The mesentery of the upper portion of the jejunum, which was adherent to the lower margin of the transverse colon, showed in its folds an accumulation of thick greenish pus.

Case VI.—Reported by Rosenbach (*Centralblatt für Chirurgie*, 1882). A woman, fifty-seven years of age, otherwise in good health, had suffered some time ago from pain in the abdomen and constipation, but was soon relieved. Three weeks before she came under observation of the reporter, the same trouble returned. The bowels had not moved for three days; frequent vomiting of greenish fluid; great weakness. On examination, a fluctuating tumor the size of a child's head was detected in the epigastric region, behind the stomach, which was considerably dilated. The tumor was immovable. As the symptoms pointed to intestinal obstruction of some kind, and failed to be relieved by enemata, it was decided to perform laparotomy, to which the patient readily consented. The abdomen was opened through the median line, but, as the tumor was not rendered sufficiently accessible, a transverse incision was made over the part most prominent. After division of the mesocolon an effort was made to enucleate the tumor, but the inflammatory adhesions were so firm that the attempt had to be abandoned. An effort was then made to push the stomach upward, but this likewise failed. During these manipulations the tumor ruptured and at first clear, then turbid offensive fluid poured out. The fluid was removed without soiling the peritoneal cavity. The sac was then stitched to the margins of the wound. After suturing the remaining portion of the external incision the opening in the sac was enlarged and drained. The patient died of shock six hours after the operation. At the autopsy the necrosed pancreas was found in the sac. The abscess cavity extended behind the stomach and lesser omentum. The intestinal obstruction was caused by pressure of the swelling upon the small intestine.

Remarks.—The pancreas may constitute one of the component parts of the intussusceptum in cases of invagination of the bowels, as such a case has been reported by Bandl, and the specimen examined by Rokitansky furnishes a similar illustration. The second case reported by Chiari may have been of a similar nature, the invaginated portion having sloughed with the remaining portion of the intussusceptum, leaving the continuity of the

bowel unimpaired by adhesions at the point of separation. If, in this instance, the necrosis was due to inflammation, we can only infer that the parapancreatic abscess ruptured into the bowel, and that the necrosed portion of the pancreas was eliminated in this manner, and that subsequently the opening in the bowel was closed. Constipation was a prominent symptom in a number of these cases, and in Rosenbach's case the symptoms of obstruction were so well marked that it was decided to perform laparotomy for its relief. This last case is also of great interest, as during life the existence of a tumor in the region of the pancreas was diagnosticated.

Modern surgery deals extensively with abdominal section for the relief and cure of peritonitis and intestinal obstruction. In searching for the cause of either of these conditions during laparotomy, the pancreas should not be forgotten, and when it is found that the primary disease is located in or around this organ, radical measures should be adopted whenever such a course appears practicable.

Whenever the sac can be stitched to the external incision this should be done, and the sac opened, disinfected, and drained. Search should be made for the necrosed pancreas, and when found detached it should be removed. As in most of these cases the retroperitoneal tissue is extensively infiltrated, a counter-opening should be made in the lumbar region above the kidney, and through drainage established. If an anterior abdominal fistula cannot be established, the course to be pursued should be the same as in treating a pancreatic abscess under similar conditions.

IX. Abscess of the Pancreas.

At the present time no one familiar with the recent advances in surgery would question the propriety of treating a suppurating cavity by incision and drainage, wherever it might be located. Some of the most valuable recent contributions to surgical literature describe improved methods in treating deep-seated

abscesses. Asepsis and effective drainage are the two cardinal points upon which we have learned to depend in the treatment of abscesses in important organs or cavities. If we can secure and maintain these two essential conditions, we can attack with immunity and a fair hope of success, any abscess wherever it may be located, and whatever its immediate surroundings may be.

In looking over the literature on abscesses of the abdominal organs, we find that modern surgery has been guided almost exclusively by the teaching of the old master: *Ubi pus—ibi evacuo.* It is somewhat surprising that abscess of the pancreas has never been made the subject of surgical treatment. The two principal reasons for this may be found in the facts that abscess of the pancreas is of rare occurrence, and that the recognition of the lesion, when it does exist, is surrounded by many difficulties. There can be no doubt, however, that in the near future abscess of the pancreas will be treated on the same principles as suppuration in any other locality.

The remote location of the abscess may offer many serious obstacles to diagnosis and a rational course of treatment; but these difficulties will be overcome by improved methods of examination, and more perfect methods of operation. As suppuration is only one of the terminations of inflammation, abscess, like inflammation, may occur primarily in the gland itself, or it may commence in the para- or peri-pancreatic tissue. If the abscess is endo-pancreatic, it may be bounded and circumscribed by the proper investment of the gland; if, on the other hand, it commences primarily outside of the gland, it appears as a diffuse abscess, which extends to the pancreas by contiguity; in other words, we speak of the abscess as a suppurative pancreatitis, or a suppurative peri- or para-pancreatitis.

Case I.—Frison ("Pancreatite suppurée," *Recueil de mém. de méd. mil.*, Mai, Juin, 1876) reports a case of abscess of the pancreas following suppurative pancreatitis, where the collection of pus did not extend beyond the limits of the gland. An otherwise healthy mulatto, twenty-eight years of age, farmer, was attacked in June, 1873, by icterus with no fever. Appetite diminished. The symptoms were not

of sufficient severity to keep him from his work. In August he complained of pain in the right hypochondriac region, which was soon followed by ascites and œdema of legs and scrotum. He was troubled at this time by an intense thirst and voided large quantities of urine, which, on examination, was found to contain sugar. The liver was enlarged and the patient emaciated rapidly. No fever or diarrhœa. Stools clay colored. Appetite gradually declined, and the patient died in a state of advanced marasmus. At the autopsy the intestines and stomach were found normal. The pancreas was enlarged to three times its normal size and infiltrated with pus; the splenic end was distended by a large abscess. Gall-bladder and bile-ducts greatly distended. Liver olive-green in color and contained three abscesses, but otherwise healthy in structure.

Remarks.—In this case the symptoms during life pointed to the liver as the seat of the disease. The jaundice was undoubtedly produced by stenosis of the bile-duct, either by a catarrhal inflammation of the duct itself, or compression of the duct by the inflammatory exudation which attended the acute inflammation of the pancreas. The ascites was more likely the result of an inflammation of the peritoneum overlying the pancreas than of an obstruction to the portal circulation. The suppuration in the pancreas was not attended by an increase of temperature. The diabetes was probably due to the disease of the pancreas, and was not a coincident affection, as a number of cases of diabetes have been reported which occurred in the course of some disease of this organ.

Case II.—Timoteo Riboli (*Schmidt's Jahrbücher*, 1859, 2, p. 177) reports the case of a woman, aged fifty-seven years, who suffered from impairment of digestion, loss of appetite, emaciation, and attacks of vomiting in the forenoon. The tongue was coated. No fever, but night sweats. Bismuth and magnesia improved the symptoms for a time, but soon the disease became aggravated. Hepatitis was diagnosticated, inasmuch as the patient became icteric and complained of a deeply seated dull pain in the region of the liver and epigastrium. Among a number of colleagues who saw the case in consultation, Tommasini was the only one who believed that the pancreas was the

seat of the disease. The patient was emaciated to a skeleton and died of inanition. At the autopsy the pancreas was found distended with pus. Gall-bladder was distended with bile. Liver congested. No other pathological conditions were found which might serve to explain the cause of death.

Remarks.—The course of the disease in this case was again afebrile. The symptoms simulated disease of the liver even more closely than in the preceding case, as no mention is made of the presence of sugar in the urine. The suppuration did not extend into the parapancreatic space.

Case III.—The following case is described by Dr. James Kilgour (*London Journal*, Nov. 1850). The patient was a man, forty-one years of age, who was treated for several years for what was termed bilious dyspepsia. In March, 1850, when first seen by the reporter, he was considerably emaciated and of a melancholic disposition. A prominent symptom was vomiting, especially in the morning, and about two hours after meals. The matter vomited was a sour, viscid fluid, varying in quantity from an ounce to a quart. Skin dry and of a yellowish hue. No diarrhœa, and the stools contained no bile. Urine of sp. gr. 1.022, normal in quantity, loaded with urates, and contained some fat. Pulse small, 100. No pain in abdomen. On left side, from border of stomach to crest of ilium, abdomen was dull on percussion, on palpation inelastic, nodulated, and of a doughy feel. The area of swelling was not well defined. Neither fluctuation nor pulsation could be felt. During the middle of the month of May, the patient complained of chilly sensations, and the area of dulness increased toward the left. Toward the end of the month the chills disappeared and the abdomen became tender and elastic above. During the latter part of July, the legs became œdematous and the patient was somewhat delirious. Toward the close of the disease he was again attacked by a number of chills and died July 28th. The autopsy revealed the stomach distended with gas, its walls very thin; pylorus indurated and slightly narrowed. Duodenum softened by inflammation, the portion near the pancreas being converted into a pultaceous mass. Liver normal. Spleen enlarged one-third. Pancreas enlarged to the size of a teacup, its left end being attached to the suprarenal capsule on same side. On incising the pancreas a milky fluid escaped. The entire gland was converted into a single sac,

which contained purulent fluid with some cheesy particles and fragments of cellular tissue.

Remarks.—In this case the symptoms were sufficiently clear which would, at the present time, enable an accurate observer to make a probable diagnosis of abscess of the pancreas. The obstinate vomiting, with the absence of signs of disease of the liver, and the progressive emaciation should have led at least to a suspicion of disease of the pancreas.

The location of the tumor was also suggestive of the primary starting-point of the swelling. The abscess cavity was larger than in the preceding cases, and the presence of pus was also suggested by the chills which were present at the beginning and close of the disease. As the abscess cavity was single, this would have been a proper case for surgical treatment. A somewhat uncommon feature in this case was almost complete absence of pain, a symptom which has been considered by Claessen characteristic of disease of the pancreas. The character of the fluid in the cyst would indicate that it was a mixture of pus and pancreatic juice. As in other secretory organs, the suppurative process may commence in the duct and extend to the interstitial connective tissue by continuity. This is the manner in which the presence of foreign bodies, such as parasites or calculi, in the duct gives rise to abscess of the pancreas. In the following case the inflammation of the duct and the consecutive interstitial suppurative pancreatitis were attributed to the presence of an intestinal worm.

Case IV.—Reported by Shea (*Lancet*, November 5, 1881). The patient was a woman, aged twenty-nine years, who complained of abdominal pain and was jaundiced. After a few days, she improved under a mild alkaline treatment, but about three weeks subsequently again became worse. The pain was in the region of the pancreas. At the same time she suffered from nausea followed by vomiting; jaundice reappeared. Active treatment was resorted to, but she soon became unconscious and died forty-eight hours subsequently. The necropsy showed that the body was fairly nourished and distinctly jaundiced. The lungs were slightly congested at the base. Liver large, pale, and

soft. Pancreas enlarged and hard, being the seat of an abscess containing pus. A round worm, seven inches long, was found folded upon itself, lying in and obstructing the pancreatic duct, the larger portion of the worm being in the duodenum. The intestines were healthy. In the absence of any other disease, death in this instance must have resulted from inflammation of the duct and parenchyma of the pancreas by the irritation induced by the presence of the worm. The jaundice was undoubtedly produced by the same cause.

Positive evidence is wanting in this case to prove that the suppuration was caused by the presence of the parasite, as the worm might have entered the pancreatic duct after death. We have evidence that in many cases ascarides were found in the ductus pancreaticus, without the presence of abscess or even inflammation. Davaine (*Traité des Entoz.*, p. 115) relates that he has found them present in this locality in four cases, and in none of them had secondary inflammatory changes taken place. Klebs found six worms in one case, four in the head and two in the tail of the pancreas.

Case V.—Mayo refers to a case that came under the observation of Percival (*Outlines of Human Pathology*, London, 1836, p. 409). The patient was a gentleman who had jaundice and bilious vomiting. A tumor appeared at the epigastrium; his strength failed; blood and fetid pus were discharged by stool, and he died exhausted in three months. At the necropsy the pancreas was found greatly enlarged and contained a considerable abscess; the ductus communis was obliterated by the pressure.

The class of cases which are of special importance and interest to the surgeon are those diffuse abscesses which take their origin in the parapancreatic connective tissue: extensive collections of pus as we observe them in cases of parapancreatitis purulenta. As the glandular tissue is not primarily affected in these cases, early evacuation and drainage of the abscess cavity would not only preserve the anatomical and functional integrity of the gland, but would also serve as a life-saving measure by securing an early outlet of the abscess contents.

The case reported by Haller and Klob, and referred to under the head of pancreatitis, Case I., furnishes a good illustration of cases belonging to this class.

Case VI.—An interesting case of abscess of the pancreas has recently been reported by Musser (*American Journal of the Medical Sciences*, April, 1886, p. 449). The patient was a male, aged forty-two, shoemaker, who was admitted to the wards of the Presbyterian Hospital, May 12, 1885, and died June 6th following. He was of intemperate habits, but his general health had always been good. His poverty had exposed him to all kinds of hardships. The duration of the present illness was not known, but from his statements it was ascertained that his health had been failing all spring. He had never received any injury. He was considerably emaciated. He vomited only once, and that was on the day of admission. Marked ascites was observed, but nothing else could be found. He remained in a stupid condition, took but little food, and manifested no signs of pain. No fever, no sweating. Palpation showed the liver and spleen to be normal, while an ill-defined tumor could be felt in the epigastric region. Urine contained a trace of albumen, but no casts. The ascites was so great as to warrant tapping, and this was accordingly done. The abdomen was thirty-six inches in circumference at the umbilicus before tapping. Within eighteen hours after tapping, it had filled entirely, and in twenty-four hours measured thirty-two and a half inches. He died of exhaustion.

After death, by palpation a fixed mass was detected in the abdomen, extending from the right mammary line, one inch above the umbilical line, directly across to the corresponding line on the left side. Its upper margin was not well defined, but it appeared to be two inches wide. The abdomen was filled with serum in which some lymph floated. The intestines were matted together by recent lymph. The peritoneum showed signs of inflammation. Corresponding to the position of the mass indicated by palpation, the omentum was found matted together, with its inferior border turned upward, and lying across the stomach. This organ was fixed and dilated, its inferior border extending to the umbilicus. The liver occupied its normal position. The transverse colon extended across the abdomen along the lower margin of the stomach, thus permitting the omentum to occupy the position indicated above. Further study of the relations of the abdominal organs revealed the formation of a large cavity

containing about a quart of pus. This cavity was formed by the posterior wall of the stomach in front, by the pancreas, duodenum, and transverse colon below, and by an extension, or rather distention, of the peritoneum above and behind. Certainly the pus did not fill the retroperitoneal space or extend into it, and was not in close apposition to the diaphragm or brim. It was situated in the duodeno-jejunal fossa. Adhesions prevented communication with the abdominal cavity and the retroperitoneal space. This abscess cavity communicated with an abscess the size of an orange, situated in the head of the pancreas, its point of rupture into the duodeno-jejunal fossa being in the middle and upper part.

The remainder of the pancreas was made up of dense connective tissue, throughout which there were innumerable pus pockets, varying from a pea to a pecan nut in size. The secreting tissue of the organ was not discernible to the naked eye. The ducts were not occluded, but rather dilated, and no calculi were found. The portal vein was filled with a purulent thrombus. The splenic vein was also partially closed by a soft thrombus. The superior and inferior mesenteric veins were completely blocked by laminated thrombi, which were firmly adherent to their walls. On microscopical examination, the pancreas was found to be made up of old and young connective tissue; in the large interstices of the bundles of old tissue, the glandular structure could be readily made out, while the tubules were seen to be in a state of catarrhal inflammation. The intertubular connective tissue was crowded with young cells.

Remarks.—In this case the conditions were favorable for successful treatment by abdominal section had even a probable diagnosis been made before the extensive and serious complication of thrombo-phlebitis occurred. The symptoms during life simulated cirrhosis of the liver so closely that it was impossible to differentiate between this affection and disease of the pancreas, although an ill-defined tumor could be felt in the epigastric region. In similar cases an exploratory laparotomy should be done for the purpose of making a positive diagnosis, and, when similar favorable conditions are found, it could be followed at once by radical measures with a view of securing evacuation and drainage of the abscess cavity. In this case the abscesses in the viscus were the result of a purulent pancreatitis; the

secondary abscess, of perforation into the duodeno-jejunal fossa followed by suppurative peripancreatitis.

Pathology of Abscess of the Pancreas.

Recent investigations have shown the existence of a direct causative relation between the pus microbes and suppuration, hence we must take it for granted that every purulent pancreatitis, peripancreatitis, or parapancreatitis is caused by the presence of these germs in the tissues. In case there is no direct invasion by a loss of continuity of the hollow viscera in the vicinity of the pancreas, or no direct communication with the external air by a penetrating wound, we must assume that the germs reach the gland through the circulation, and find a favorable soil prepared by some antecedent pathological change. Such conditions may be determined by contusion of the organ, disturbance of the capillary circulation by various causes, or thrombophlebitis. Norman Moore reports the case of a female, twenty-seven years of age, who had died of pyophlebitis, and where, on post-mortem examination, beside the portal, splenic, and vena azygos minor veins, the pancreatic veins were also blocked by decolorized and adherent thrombi. ("Pathological Observations on the Pancreas," *St. Bartholomew's Hospital Reports*, vol. xviii. p. 207.)

In the *Pathological Society's Transactions* the same author gives an account of two cases of abscess of the pancreas due to plugging of the pancreatic vessels. On page 210 he remarks:

"Pathologically, the case in which thrombosis of the pancreas was found is interesting as indicating how pancreatic abscess is produced. The much commoner condition of the liver in the other cases shows that, had the first patient survived, the thrombosis would certainly have been followed by abscess. Clinically, the value of the case is that it may, in rare cases, help to explain the seat of an obscure abdominal swelling, associated with fever, which has followed a thrombosis, and which physical examination cannot localize in the liver."

Suppuration always begins in the interstitial tissue, either within the gland or in the connective tissue around it. A sup-

purative inflammation and formation of an abscess are different stages of the same process. Peripancreatitic suppuration commences, in most instances, in the adjacent lymphatics, the pus surrounding the lymph glands, or forming a small abscess.

In the vicinity of the pancreas these perilymphatic abscesses are not unfrequently met with as one of the pathological conditions of pyæmia. Thus, an abscess in the pancreas with perforation into the peritoneal cavity, was examined by Perle (*De Pancreas ejusque morbis*, Dissert. Berol., 1837). Tulpius saw an abscess of the pancreas as a secondary lesion after an attack of malarial fever. Schmackpfeffer observed the same condition after an operation for strangulated hernia, and Portal after extirpation of a testicle. But suppuration in the pancreas sometimes takes place as an independent affection, without the presence of an appreciable infection-atrium, and in these cases we must assume that the essential and specific noxæ are carried along with the circulating blood, and that localization takes place upon a soil prepared for their reception and growth by previous alteration in texture or circulation. In some instances the process begins upon the outer surface of the gland, the pus separating the gland from its attachments. In the case described by Gendrin the pancreas appeared to have been completely detached, and was lying loose in the abscess cavity.

Many of these parapancreatic abscesses do not present well-defined borders; the pus manifests a tendency to burrow in the vicinity of the mesocolon and the retroperitoneal space, and is apt to perforate into the bursa omentalis, or into some other portion of the peritoneal cavity, or, lastly, finds its way into one of the adjacent hollow organs, as the stomach or intestinal tract. Van Derveren reports the case of a female, fifty-nine years of age, who had suffered for thirty years from attacks of gastralgia. At the necropsy, it was ascertained that the indurated pancreas had perforated the posterior wall of the stomach. The opening represented a round ulcer, two and a half inches in diameter, with indurated margins. In this aperture eroded vessels could be seen. The fistulous tract communicated with the pancreatic duct. The stomach and intestines contained

blood, but no other evidences of disease could be found. In Percival's case the abscess ruptured into the bowel, the stools containing fetid pus and blood. A similar case was observed by Haggarth (*Transactions of the College of Physicians in Ireland*, vol. ii.). The suppurative process, however, may extend in an opposite direction, from the stomach to the pancreas (Rokitansky, *Lehrbuch der pathol. Anatomie*, Wien, vol. iii. p. 168). A communication between the stomach and pancreas is sometimes established by perforation of a gastric ulcer in this direction. Around the margins of the ulcer, between the stomach and pancreas, adhesions are formed, an occurrence which prevents extravasation of the contents of the stomach into the peritoneal cavity. A number of the terminal openings of the ductilis pancreaticis have been observed upon the cicatrized surface of a gastric ulcer. In place of the formation of a permanent pancreatico-gastric fistula as described by Rokitansky, perforation of the stomach in closer proximity to the pancreas may give rise to diffuse and rapidly fatal parapancreatitis or peripancreatitis.

The indirect primary cause of a pancreatic abscess may be due to the presence of a calculus in the pancreatic duct. Fournier has recorded a case where, on post-mortem examination, an enormous abscess was found in the head of the pancreas, which contained numerous calculi. The tumor was sufficiently large to be readily detected in the epigastric region during life.

An abscess of the pancreas may also originate in a pre-existing cyst of the organ. Kilgour's case, detailed above, had undoubtedly such an origin. The abscess cavity was as large as a teacup, and contained a milky fluid and caseous particles, which were undoubtedly a mixture of pus and pancreatic juice. The disease was attended by chills and fever, which indicated that the retention cyst had become the seat of an acute suppurative inflammation.

As primary, idiopathic, uncomplicated, purulent inflammation of the pancreas is an exceedingly rare affection, it is of great practical importance in the surgical treatment of such cases to

determine, if possible, the predisposing cause or causes, and to remove them, or render them inert at the time of operation.

Symptoms and Diagnosis.

The presence of pus within the pancreas or in its immediate vicinity is not indicated by any characteristic or positive symptoms. The symptoms always point to the stomach or liver as the seat of the disease. The most prominent and constant symptoms which have been observed are nausea, vomiting of a clear greenish or viscid fluid, thirst, loss of appetite, constipation, progressive emaciation, and distention of the epigastrium.

In most all cases the patients presented a sallow, cachectic appearance, and were exceedingly anæmic. Ascites and œdema of the lower extremities were present a number of times. In several instances the inflammatory process in the pancreas extended to the bile-duct, or caused stenosis of the duct by compression, conditions which are followed by biliary retention, a symptom which has been usually interpreted as an evidence of primary disease of the liver or bile-ducts. The progressive anæmia and emaciation, in the absence of other tangible lesions, are symptoms which always should direct attention to the pancreas as the seat of the disease.

Fever was seldom a conspicuous and never a constant symptom of suppurative pancreatitis. The use of the thermometer in the diagnosis of suppuration in this locality is important, but it furnishes no positive evidence. If the abscess is large, it will be recognized by palpation and deep percussion as a tumor in the epigastric region. In such cases a probable diagnosis may be made by a careful and systematic physical examination and reasoning by exclusion.

An abscess within the gland is always located in the bursa omentalis; a peripancreatic abscess in the bursa omentalis, duodeno-jejunal fossa, or upper portion of the peritoneal cavity; and a parapancreatic abscess in the retroperitoneal space. Inflation of the stomach will often serve a useful purpose in the differential diagnosis of tumors in the epigastric region. In

obscure cases, manual exploration of the rectum may add important and sometimes decisive information.

Age is also an important element to be considered in the diagnosis. Most of the cases of abscess of the pancreas were patients of more than forty years of age, and often persons of intemperate habits. Puncture with an aseptic capillary needle will demonstrate the presence or absence of pus, but will not add material information in locating with accuracy the abscess cavity.

Finally, in all cases where a tumor can be felt in the epigastric region, and a probable diagnosis can be made regarding its benign character, an exploratory laparotomy should be resorted to for the purpose of making an accurate anatomical diagnosis.

Prognosis.

The prognosis of abscess of the pancreas is always unfavorable. Death is produced by progressive emaciation and inanition, by septic absorption, or secondary lesions in adjacent. organs. In acute, diffuse pancreatic abscess a fatal termination may take place in a few days. One of the great dangers of abscess in this locality is the close proximity of numerous important veins, which become implicated by extension of the suppurative inflammation to their walls, producing a suppurative thrombophlebitis, with all its disastrous consequences. Perforation of the abscess into the stomach or intestinal tract is the most favorable spontaneous termination, and has resulted, at least in one instance, in a cure. Perforation of the abscess into the peritoneal cavity would hasten death by inducing a rapidly fatal septic peritonitis.

Treatment.

The remarkable success which has attended the treatment of pelvic and abdominal abscesses by laparotomy justifies the hope that, in the near future, the same treatment will be extended to abscess of the pancreas. It is true that the difficulties which

surround the treatment of abscesses in this region are many, but they are not insurmountable. Multiple abscesses, disseminated throughout the entire organ, and especially its head, are not amenable to successful surgical treatment. Circumscribed endopancreatic abscess in the peripheral portion of the body or tail of the pancreas should be treated by partial excision of the pancreas in all cases where the isolation of that portion of the organ can be accomplished without inflicting serious injury to adjacent important organs. When extirpation is impossible, as when the abscess is located in the head of the pancreas, it must be treated by incision and drainage. This is accomplished in the same manner as in the treatment of a pancreatic cyst. In some instances, the access to the abscess is rendered difficult by distention of the stomach, the dilated organ overlapping the pancreas. In such cases, the stomach must be pushed upward, and subsequent distention guarded against by ordering an absolute diet until the external fistula has been established. The external incision must, in all cases, correspond to the most prominent part of the swelling, as it is of the greatest importance to incise the abscess at a point where the distance between the surface of the abscess and the abdominal wall is the shortest. Incision of the great omentum will be required in all instances.

In making an external fistula in the treatment of a pancreatic abscess it is essential to protect the muscular and connective tissues of the external incision against contact with pus by lining the margins of the wound with the parietal peritoneum before the serous covering of the anterior wall of the abscess is stitched to the margins of the wound. One of the greatest difficulties that will be encountered in this operation will be the approximation of the peritoneal surface of the abscess with the margins of the wound, on account of the distance between the surface of the abscess and the anterior abdominal wall; this difficulty will decrease in proportion to the prominence of the swelling.

The size of the external incision will exert an important influence in this direction. If the incision is large the margins of the wound can be turned inward, thus facilitating the suturing

of the anterior wall of the abscess to the margins of the wound. As a rule, it may be relied upon that the anterior wall of the abscess, covered by peritoneum, is quite thick, so that there is little danger of penetrating the abscess cavity with the needle in suturing. Previous evacuation of the abscess cavity by aspiration would diminish the danger of extravasation of pus through the needle punctures, but would also render approximation difficult by the recession of the abscess wall, and should, therefore, not be resorted to unless the swelling is sufficiently prominent to render this circumstance of little importance.

As the suturing of the two peritoneal surfaces is done for the purpose of preventing, in the first place, extravasation of pus into the peritoneal cavity; and, secondly, of securing permanent adhesions between the abscess wall and the margins of the wound, it is important to apply the sutures closely together and to grasp the tissues in such a manner that tearing through of the sutures is impossible. As considerable tension may follow, it would be advisable, in this particular instance, to use silk sutures. As in these cases time is an important element, incision and drainage should follow suturing immediately.

The remaining steps of the operation will depend upon circumstances. If the abscess is endopancreatic or peripancreatic, simple incision, drainage, and disinfection will answer all indications. If, however, the purulent cavity is located behind the peritoneum and occupies the connective tissue space behind the pancreas, it would appear rational to drain the abscess posteriorly through one of the lumbar regions above the kidney by pushing a long closed forceps in a proper direction through the posterior and lateral wall of the abscess until its point can be felt under the skin externally. A small cut in the skin over its point will enable the operator to push the instrument clear through, and, by dilating its blades, widen the canal sufficiently to permit the insertion of a large drainage tube. In this manner the most desirable method of drainage—through drainage—could be established, which would render subsequent disinfection and evacuation of the abscess a comparatively easy task. In

cases where an anterior pancreatic fistula cannot be established on account of the distance between the abscess and the anterior abdominal wall, we might resort to lumbar drainage and closure of the incision in the anterior wall of the abscess by carefully inverting and approximating the peritoneum over the wound with fine silk sutures.

That the utmost care in the application of antiseptic precautions should be resorted to in the evacuation of pus in this remote region by any of these procedures requires no argument. I will repeat that a positive diagnosis of the presence and precise location of a pancreatic abscess is only possible by resorting to explorative laparotomy, and that this diagnostitial aid should be always resorted to when the history of the case and the symptoms and signs presented are sufficiently suggestive to point to a probable diagnosis.

The abscess found and located by abdominal section should be removed by partial extirpation of the pancreas when it is endopancreatic and located near the splenic end of the pancreas. When extirpation is impossible, or when it is located in the head or on the anterior surface of the pancreas, it should be treated by the formation of an anterior abdominal fistula; when located behind the pancreas, by through drainage, or lumbar drainage performed through the abdominal cavity.

X. Hemorrhage of the Pancreas.

A number of post-mortem examinations have shown that certain cases of sudden death were caused by hemorrhage of the pancreas, inasmuch as no other evidences were found which could explain the cause of death. In some as yet unaccountable way, even a moderate hemorrhage in this locality has been sufficient to destroy life. Zenker has affirmed that in these cases pressure upon the solar plexus and semilunar ganglion produces paralysis of the heart, to which he attributes the immediate cause of death. If we recollect that tumors of the pancreas, even when of considerable size, do not destroy life in this man-

ner, it seems that the true explanation of the great danger which attends hemorrhage of the pancreas remains to be ascertained. Practically it is important to differentiate between diffuse hemorrhage into the substance of the organ and its adjacent tissue, and circumscribed accumulations of blood or hemorrhagic cysts of the pancreas, as the latter condition presents more favorable indications for surgical treatment.

Hemorrhagic Cysts.

Case I.—Anger (*Bulletin de la société anatomique de Paris*, xl., Année 1865, 2me série, tome x. p. 192) reports a case of hemorrhagic cyst of the pancreas in a man, aged seventy-two years, who had been a soldier for ten years, during which time he had received several wounds. Later he suffered fracture of several ribs on the left side from a severe contusion, from which injury, however, he recovered completely after three months' treatment in the hospital. No history of syphilis. Five months ago lower limbs became œdematous, and for the last six weeks ascites was present. He was admitted into the Beaujon Hospital February 27, 1865. At this time the following conditions were noted: Œdema of lower extremities; ascites; breathing difficult and stertorous; bronchitis on left side of chest, and hydrothorax on opposite side. Diaphragm pushed upward. Pulse 100, irregular and intermittent. Diarrhœa and loss of appetite. No delirium. Urine contained no albumen. A stimulating treatment was adopted. March 1st the patient died, the pulse having been for a time exceedingly feeble and intermittent. The breathing toward the last was very labored and the patient was unable to lie down.

Autopsy. Pleuritic effusion on left side, bronchitis. Liver small, somewhat contracted, but not cirrhotic. Serous effusion in pericardium; heart dilated, mitral valve insufficient. On opening the abdomen a tumor, the size of a fœtal head, was found in front of and on the same niveau with the left kidney. This tumor was bounded in front by the stomach and the transverse colon, above by the diaphragm, below by the descending colon, behind by the kidney, toward the median line by the pancreas, and on the outside and above by the spleen. It was loosely connected with the kidney and spleen by connective tissue, in which the vessels of these organs could be readily seen. The tumor was evidently connected with the pancreas.

The external surface was irregular and nodulated, the anterior wall of variable thickness. Fluctuation plain. The vessels of the spleen were intimately connected with the posterior surface and were not easily isolated. On careful dissection the lobules of the pancreas could be separated from the tumor, but the walls of the cyst contained a tissue which resembled glandular structure. On opening the cyst a considerable quantity of dark fluid blood escaped, which contained a number of small, recent coagula. The inner surface of the cyst was uneven and reticulated, resembling in appearance the interior of the right ventricle. On the surface of the prominences, diverticula could be seen, which were in free communication with the principal cyst. The wall of the cyst was very much indurated and thickened at four or five places. Some of these nodules were fibro-cartilaginous in structure, while others had undergone calcification.

Sections of the cyst wall showed under the microscope nucleated epithelial cells which resembled in structure the epithelial cells in the pancreas. Acinous groups of glandular tissue were also found. The reticulated structure in the interior of the cyst contained vessels and remnants of the acini. The author came to the final conclusion that the tumor was a cyst, located in the tail of the pancreas. The presence of blood in the cyst was explained by the supposition that, during the progressive dilatation of the cyst, some of the vessels in the connective tissue reticulum had ruptured.

M. Le Dentu, who examined the cyst, also came to the conclusion that the bleeding had taken place into a preëxisting cyst. What symptoms the presence of the tumor had produced during life could not be ascertained, as the patient was being treated for organic disease of the heart and the tumor was not recognized during life.

Case II.—Störck (*Archiv gén. de Paris*, Mai et Juillet, 1836) observed the following case. The patient was attacked during the menstrual period by vomiting, which was followed by coldness of the extremities, palpitation of the heart, and dyspnœa. Soon after this time a pulsating tumor was detected in the epigastric region, which caused considerable pain. The patient also suffered from constipation and attacks of vomiting. She died three and one-half months after the first attack. At the autopsy the entire pancreas was found enormously dilated, and weighed with its contents thirteen and one-half pounds. On cutting into it, it was found filled with coagulated

blood. Judging from the condition of the coagula, bleeding had occurred at intervals. The weight of the tumor had caused injurious pressure upon adjacent organs. Le Dentu believed that the hemorrhage was caused by the act of vomiting and had taken place into a preëxisting cyst of the pancreas.

Case III.—John Parsons (*British Medical Journal*, 1857) reports a case where hemorrhage into a preëxisting cyst proved fatal after the latter had ruptured into the intestinal tract. The patient was a female, sixty years of age, who had suffered from vague dyspeptic symptoms for an indefinite length of time. When she was examined by the reporter a fluctuating tumor the size of an orange could be felt in the epigastrium, just below the greater curvature of the stomach. Emaciation progressed rapidly. The tumor disappeared suddenly, at the same time a viscid, dirty white fluid was discharged through the bowels. The tumor reappeared in a short time, and ruptured a second time into the intestines, followed by hemorrhage into the ruptured cyst which proved fatal. At the autopsy, the pancreas was found excavated into a wide canal which, at either extremity, was dilated into a cyst. The walls of the cysts were of the firmness of cartilage, and the organ was adherent to the stomach, kidney, and colon. Coagulated blood was found in the dilated duct and cysts.

Remarks.—In Anger's case there is room for speculation concerning the origin of the cyst and the source of hemorrhage. As the cyst had not ruptured and did not remain in communication with the patent pancreatic duct on the proximal side, we can only explain the absence of altered pancreatic juice or at least the absence of cyst contents previous to the occurrence of hemorrhage, by assuming that absorption took place as hemorrhage increased, if we adopt the idea that the bleeding occurred into a cyst which had formed before hemorrhage took place.

Two other explanations might be offered. First, that the parenchymatous hemorrhage produced the cyst, the circumscribed coagulum separating the interstitial tissue, and the lining of this space with endothelial cells developed from the connective tissue cells, and subsequent hemorrhage from the interior

of the cyst wall. Again, the hemorrhagic cyst might have originated in a dilatation of one of the vessels of the pancreas, a varicose ectasia of a vessel.

In the second case it appears more than probable that hemorrhage occurred by rupture of a vessel and extravasation of blood into the altered parenchyma of the gland, distending the entire capsule of the organ—in other words, a hæmatoma of the pancreas. In Parson's case the clinical history and the post-mortem appearances prove beyond all doubt that the fatal hemorrhage took place into a preëxisting pancreatic cyst. The immediate cause of hemorrhage in this case was undoubtedly due to inflammatory changes in the interior of the cyst after the first rupture, and to sudden diminution of intracystic pressure by the second rupture.

Diffuse Hemorrhage.

Case I.—Reported by H. Hudson Rugg (*Lancet*, May, 1850). A man, aged forty-two years, had just recovered from an attack of acute articular rheumatism, when he was attacked suddenly with a severe pain in the left lumbar region. He became collapsed almost instantly. This was followed by cold, clammy sweat and other symptoms of acute anæmia. He never rallied, and died within a few hours. On opening the abdomen after death a large quantity of recently extravasated blood was found between the pancreas and left kidney. A careful search for the source of hemorrhage was made, when it was found that the blood had escaped through an opening of considerable size, which presented the appearance of an ulcer on the anterior surface of the pancreas, which contained a blood-clot the size of a walnut. Sections through the pancreas showed a number of small excavations filled with blood, the size of a hazelnut and smaller, which looked like aneurismal dilatations.

Case II.—Reported by Oppolzer (*Medizinische Neuigkeiten*, April, 1859). The patient suffered from severe pain in the epigastric region, followed by vomiting, which always aggravated the suffering. The vomited matter consisted of mucus and bile. The disease was attended by fever, very frequent pulse, cold extremities. The bowels were constipated. No blood was vomited, and the case was diagnosticated as

perforating ulcer of the posterior wall of the stomach. On the third day after admission to the hospital he died. At the autopsy the stomach was found in a healthy condition, but around the pancreas and between the layers of the mesentery a copious effusion of blood was found. The pancreas was the source of hemorrhage. This organ was enlarged to double its normal size, of dark red color, and on section was found infiltrated with a blood-stained exudation between the acini.

Case III.—Reported by Hilty (*Correspondenzblatt für Schweizer-aerzte*, Nov. 15, 1877). The patient was a mechanic, aged thirty; tall, stout, and muscular, but of intemperate habits. One evening he drank beer to excess, and on the following morning without any premonitory symptoms he was seized suddenly with a painful tension of the abdomen, which gradually increased in intensity. He was sent to the hospital, where on examination, he was found in a collapsed condition. Extremities cold, forehead covered with a cold, clammy perspiration. All the symptoms indicated acute anæmia. On physical examination nothing abnormal was found, except that the upper part of the abdomen was distended and painful, especially to pressure. Diagnosis of poisoning or gastritis was made, and treatment adopted in accordance with this view. The patient never rallied, and died in the evening of the following day. At the necropsy the omentum and mesentery were found loaded with fat. No abdominal effusion and no trace of peritonitis. The diaphragm was pushed upward as high as the fourth rib. In the connective tissue around the pancreas a copious effusion of blood was found. The pancreas was double its normal size, firm in structure, and of a dark violet color. On section the lobules were seen to be of a dark color, and the interlobular tissue infiltrated with blood; this infiltration was most copious in the head of the organ. The gland duct was normal, but the vein running along the lower border of the pancreas was distended with blood-clots. No other pathological conditions were found which could explain the sudden death.

Case IV.—Described by Portal (*Traite de l'apoplexie*, Paris, 1811). This is the first case of this kind on record. A merchant had suffered for two years from colicky pain in the abdomen, nausea, and diarrhœa; emaciation appeared early and continued progressively. Twenty days before his death fever made its appearance. The pancreas presented

a violet color, was softened, and from its whole surface exuded a black offensive fluid. Stomach and duodenum showed evidences of inflammation at some points adjacent to the pancreas.

Case V.—Reported by Haller and Klob (*Wiener Zeitschrift*, N. F., 11, 37, 1859). Patient was a man, sixty-six years of age, who had died after a short illness. The pancreas was found almost completely detached, its only connection with the adjacent organs being a few strings of connective tissue. It was surrounded by a serous fluid. The stomach was perforated from without, the cells of the pancreas were disintegrated, granular, and changed into detritus, and the splenic vein was filled with a thrombus.

Kollman (*Bayr. ärzt. Intelligenzbl.*, No. 39, 1881) reports two cases of hemorrhage of the pancreas, the first of which came under his own observation, and the second under the care of Gerhard.

Case VI.—Female, suffering from stenosis of mitral valve and pleuritis on left side. One afternoon, after having partaken of a liberal dinner, she had an attack of diarrhœa, but no vomiting. During the night she had a chill, and an anxious sensation with jactitations. In the morning of the following day she felt greatly improved, but soon after expired suddenly. At the autopsy there was found subperitoneal extravasation of blood at the pyloric end of stomach. Mucous membrane of duodenum along the convex side was infiltrated with blood, but intact. Pancreas hyperæmic, and surrounded with an extravasation of blood, which was most marked in the retroperitoneal connective tissue, extending to the hilus of the spleen. The tail of the pancreas was more hyperæmic than the remaining portion of the gland, and infiltrated with blood.

Case VII.—The patient was a female, who, from the symptoms presented, was supposed to suffer from bronchial catarrh, emphysema, ascites, and anasarca. She was suddenly seized with collapse, and died in a few hours. At the necropsy the subperitoneal tissue of the duodenal peritoneum was suffused with blood. Considerable hemorrhage into pancreas, and the retroperitoneal space behind pancreas distended with blood.

Remarks.—A careful perusal of the above cases must satisfy the most casual observer that the hemorrhage was produced by different causes, and constituted simply an expression of different pathological conditions. In the material presented three distinct, primary, pathological conditions will be recognized: 1. Disease of the bloodvessels of the pancreas; 2. Chronic parenchymatous degeneration of the gland; 3. Acute hemorrhagic pancreatitis.

In Rugg's case the patient had just passed through the stages of acute articular rheumatism, and had not suffered from symptoms referable to organic disease of the pancreas, when he died suddenly from internal hemorrhage, which was traced to the pancreas. The pancreas itself showed no other pathological changes, except circumscribed cavities filled with blood, which are referred to as resembling aneurismal sacs.

Case III., reported by Hilty, is an illustration of the second class. Extensive fatty degeneration was found to exist in the tissues generally. Klob found interstitial hemorrhage in the pancreas, in connection with chronic interstitial inflammation of the pancreas, and as a result of prolonged congestion of the portal vein. Zenker reported three cases, which he observed in the course of one year, to the Naturforscher Verein at the Breslau meeting in 1875. In all, the amount of blood extravasated was slight. His observations on hemorrhagic infiltration of the pancreas as a cause of sudden death are of great importance to the medical and legal profession. Death from this cause takes place more frequently than is generally supposed.

The facts observed by Zenker were nearly the same in all cases. A corpulent subject died suddenly, or was found dead. Post-mortem examination revealed, as the only tangible pathological change, hemorrhagic infiltration of the pancreas and neighboring connective tissue, and advanced fatty degeneration of the pancreas.

Further, there was found in two cases bloody effusion in the duodenum, and in two excessive engorgement of the semilunar

ganglion. Zenker believes that paralysis of the heart, whether directly or indirectly caused, must be regarded as the immediate cause of death in these cases. Diffuse infiltration is more common than circumscribed, showing that the same cause exists throughout the entire gland. The bloody effusion is usually not limited to the capsule of the gland, but infiltrates the adjacent spaces, more especially the retroperitoneal connective tissue. The gland is softened, the anterior serous covering disorganized, and the extravasated blood escapes into the bursa omentalis. These conditions are followed rapidly by death, so that even the peritoneum does not show any secondary changes.

In the last class of cases, where the hemorrhage occurs as a symptom of a peculiar and exceedingly malignant form of inflammation of the pancreas, we have reason to believe that the inflammation is due to the presence of a specific form of infection. Klebs believes that in these cases the corroding qualities of the pancreatic secretion may induce the destructive process. Reasoning from analogy, it is, however, probable that the immediate and essential cause is to be found in some form of microbic infection.

The last two cases illustrate that prolonged congestion of the abdominal organs, from obstruction to the return of venous blood, may act as an exciting cause in producing parenchymatous hemorrhage into the pancreas altered by antecedent pathological conditions.

Symptoms and Diagnosis of Hemorrhage of the Pancreas.

The premonitory symptoms which precede the hemorrhage are referable to the particular kind of tissue changes in the pancreas which predispose to rupture of the bloodvessels. In all instances of pathological hemorrhage we have the usual train of symptoms which point to the textural changes in the pancreas as the seat of lesion. Loss of appetite, nausea, vomiting, epigastric pain, constipation, and debility are the most prominent symptoms in cases of degeneration of the pancreas. When the hemorrhage takes place in the course of an infective,

hemorrhagic pancreatitis, we have a complexus of symptoms indicating the presence of an acute inflammation of the organ, usually attended by a rise in temperature. In some cases the hemorrhage produces death so rapidly, that the symptoms which attend this occurrence are of such short duration, that it has been impossible to determine them by actual observation. When the patient dies from loss of blood, the accident is announced by the well-marked symptoms indicative of external hemorrhage: a sharp pain in the region of the pancreas, followed almost immediately by collapse, cold extremities, absence of pulse, cold, clammy perspiration, and a speedy death. If hemorrhage takes place into a preëxisting cyst, the presence of which has been previously determined, the accident may be suspected if pain is suddenly increased, the tumor becomes larger and more tense, and more particularly if the patient's condition indicates a sudden increase of anæmia. Physical examination can be of value only if hemorrhage occurs into a preëxisting cyst of considerable size, or if the effusion of blood is sufficiently copious to give rise to an appreciable swelling in the immediate vicinity of the pancreas.

Treatment.

The propriety of surgical treatment of pathological hemorrhage of the pancreas can only be entertained when the accident takes place in consequence of circumscribed, benign, pathological conditions, which in themselves do not jeopardize the life of the patient, and which admit of measures for arresting hemorrhage by direct treatment. Operative interference should, therefore, be limited to the class of cases described under the head of hemorrhagic cysts of the pancreas. In well-defined cases belonging to this group, it would be justifiable to resort to abdominal section as the only means of arresting fatal hemorrhage, by direct ligation of the bleeding points, or by removing such localized portions of diseased tissue from which the hemorrhage has taken place.

For instance in Case I., partial excision of the pancreas in

which the ectatic vessel had ruptured would have definitely arrested the hemorrhage without interfering with the physiological function of the remaining portion of the gland. When profuse hemorrhage takes place into a preëxisting cyst of the pancreas, further hemorrhage can be effectually arrested by establishing an external pancreatic fistula of large size, plugging the interior of the cyst with iodoform cotton, and applying firm elastic compression of the abdomen with a rubber-webbing bandage over the antiseptic dressing. If this procedure should fail to arrest the hemorrhage, the abdominal incision should be enlarged and an attempt made to extirpate the cyst with or without resection of that portion of the pancreas from which the cyst has grown, according to the size or location of the cyst.

In diffuse hemorrhage of the pancreas due to localized lesion, the same treatment is applicable as advised in the treatment of hemorrhagic cysts of the pancreas.

XI. Cysts of the Pancreas.

For a general consideration of this part of our subject I refer to my paper on "The Surgical Treatment of Cysts of the Pancreas," in the *American Journal of the Medical Sciences*, for July, 1885. I refer to this subject again for the purpose of adding new cases and to modify the statement then made concering the etiology of these cysts. Since then the following additional cases have been reported.

Case I.—Dixon (*Medical Record*, March 15, 1884) reports an interesting case of cyst of the pancreas, which terminated in death from compression of the bile-duct by the cyst. The patient was a male, forty-two years of age, who during a period of three months had suffered from three attacks of what seemed to be cholelithiasis, before he came under the reporter's care. For the last ten days he became jaundiced. On examination a tumor was found in the region of the gall-bladder, about four inches in diameter, which fluctuated on palpation and ascended and descended synchronously with the respiratory movements, and received the impulse from the underlying aorta. The tumor was punctured and four ounces of a yellowish-red fluid removed,

which solidified on exposure to the air. Two days after the puncture the tumor was considerably larger than before. The patient's strength gradually failed, until he died, thirty-four days after the puncture. At the necropsy it was ascertained that the tumor was a cyst of the pancreas, with thick walls, and light yellow mucous contents. The cyst occupied the head and part of the body of the pancreas and communicated with the ductus pancreaticus. The tail of the pancreas also contained a small cyst. The large cyst compressed the ductus choledochus in such a manner as to render it entirely impermeable. It is evident that in this case a removal of the pressure by operative treatment might have restored the health of the patient by removing the cause of obstruction to the natural outlet for the bile.

Case II.—Reported by Riedel (*Archiv für klinische Chirurgie*, vol. xxxii. p. 994). A woman, forty-five years of age, noticed nine years ago a small tumor in the upper portion of the abdomen, which increased slowly in size until a year and a half before she was examined by Riedel. After this time growth was very rapid, so that recently a great deal of pain and distress was experienced from the size of the tumor. When she was examined the abdomen was filled completely with a fluctuating tumor, the pelvis and the lateral regions of the abdomen were free. Laparotomy was performed August 27, 1884. The slightly adherent omentum was easily separated, the cyst was tapped, and about ten litres of a brownish fluid escaped. After evacuation of the cyst, the transverse colon could be seen immediately behind the symphysis pubis. The mesocolon had been separated with the omentum. The cyst was separated from the loose attachments with neighboring organs. Troublesome hemorrhage only occurred from the depth of the wound near the vertebral column, where a ligature *en masse* was applied and several vessels tied; the cavity of the wound, the size of two fists, was dusted with iodoform. Death from peritonitis after ninety-six hours. At the necropsy a portion of healthy pancreatic tissue was found ligatured with catgut. The interior surface of the cyst showed, for the most part, a smooth surface without epithelium. At different points it presented prominences which contained glandular tissue.

Case III.—Reported by Salzer from Billroth's clinic (*Zur Diagnostik der Pancreascyste*, Prag, 1886). Female, thirty-three years of age, not married, suffered from an attack of typhus fever when she was eighteen years old. On admission into the hospital she stated that during

her convalescence she noticed a swelling the size of a goose egg in the middle of the abdomen above the umbilicus which disappeared in a few weeks. Four years later the swelling reappeared in the same place: it was now the size of a fist, but little movable, and rendered the umbilical region prominent. The size of the tumor increased gradually, until four years ago it had attained the size of a fœtal head, and had descended below the umbilicus. A sensation of weight in the stomach, vomiting, pain in the abdomen, were the most prominent symptoms during the last fourteen days. Menstruation regular. Before the operation a systematic and careful examination showed no disease in any other organ. Circumference of abdomen below the umbilicus, ninety centimetres. An unusually large vessel was detected in the abdominal wall in the left hypochondrium, which pulsated strongly, and over which, by auscultation, a bruit could be heard. Abdomen prominent, especially in the median line. On palpation the swelling was recognized as a round, smooth, fluctuating tumor, which was in direct contact with the anterior abdominal wall and could be moved slightly from side to side. Percussion dulness over the entire area of the tumor. Both lumbar regions resonant. Spleen and kidney dulness normal. A vaginal and rectal exploration showed that the cervix and uterus were pushed toward the right side, but movable. Behind the uterus a firm tumor could be felt. The diagnosis made at the time was unilocular cyst of the left ovary. Laparotomy was performed June 5, 1885. Median incision exposed the omentum over the cyst, slightly adherent. An opening was made in the omentum, with blunt instruments, through which the cyst wall became visible. The hand introduced through this opening showed the existence of firm adhesions of the cyst wall to neighboring organs. After enlarging the external incision the gastro-colic ligament could be seen stretched over the cyst. The transverse colon lined the lower border of the cyst, and had descended behind the symphysis pubis. When this portion of the intestine was elevated, it was seen that the cyst belonged to the mesocolon. The separation of the cyst presented many difficulties, consequently its size was reduced by tapping, the opening was closed with pressure forceps, and enucleation commenced through a vertical slit in the gastro-colic ligament. Numerous mass ligatures had to be applied to arrest troublesome hemorrhage.

On the left side of the cyst the same enlarged vessel was met with that could be felt externally; it was found so intimately adherent to the cyst wall that it could not be isolated; it was, therefore, ligated

double with the accompanying vein, and divided between the ligatures. To facilitate the deep dissection the incision was enlarged upward, and the cyst opened and emptied with the patient lying upon the side. The hand was introduced into the cyst, when it was found that the attached portion extended in an upward direction. The artery previously ligated had to be tied again higher up. In completing the tedious enucleation no pedicle was found.

From the position it could be ascertained that the base of the cyst was in the vicinity of the pancreas.

After careful arrest of hemorrhage at the bottom of the wound, and the usual toilet of the peritoneum, the external wound was closed completely, no drainage being used. The patient, who had become considerably collapsed, was rallied by the administration of stimulants. In the evening, temperature 37.6° C., pulse 72, pain in abdomen, and nausea. Restless during the night. During the next few days pulse became more frequent, jaundice and diarrhœa, great restlessness and collapse, which terminated in death on the sixth day after the operation. At the autopsy extensive purulent peritonitis was found to have been the cause of death. In the transverse mesocolon a hole was found, through which a fist could be passed. Through this opening a cavity, the size of a fist, was entered, the walls of which were infiltrated with blood and pus. In the bottom of this cavity the exposed pancreas was seen, which appeared divided transversely behind the head. Along the margin of the pancreas the splenic artery and vein were found ligated, and a portion of both vessels excised. The middle portion of the pancreas was absent. A portion of the tail of the organ, five centimetres in length, remained. Spleen enlarged to twice its normal size, otherwise normal in structure. Remaining organs healthy. A microscopical examination of the cyst showed that its walls contained pancreatic tissue. Inner surface not lined with epithelial cells.

Case IV.—Reported by Kramer, operation performed by Hahn (*Centralblatt f. Chirurgie*, No. 2, 1885). Female, sixteen years of age, after an attack of vomiting and pain in the abdomen noticed a gradual distention of the upper portion of the abdominal cavity. The size of the tumor and the area of dulness corresponding were about the same as in my case. The dulness appeared to be continuous with the hepatic dulness. Echinococcus cyst of the liver was diagnosticated. Laparotomy was performed, and the omentum divided between the stomach and the transverse colon. About two litres of an albuminous

fluid were removed by tapping. The cyst was stitched to the margin of the abdominal wound, incised, and drained. The patient recovered with an external pancreatic fistula, which continued to secrete pancreatic juice for four months.

Remarks.—The experiments made for the purpose of ascertaining the effect of complete and permanent obstruction of the pancreatic duct, as detailed in the first part of the paper, have demonstrated conclusively that obstruction is not the only nor the most important element in the causation of a pancreatic cyst. That the ligated portion of the pancreas continued to secrete pancreatic juice was demonstrated by the experiments on external pancreatic fistulæ, and yet, of the many cases of ligation of the pancreas, in not a single instance was a cyst, or even an attempt at the formation of a cyst, observed. The only physical evidence of obstruction was apparent in a moderate and uniform dilatation of the duct behind the ligature. The most important etiological factor in cases of cysts of the pancreas must be sought in an arrest of absorption of the pancreatic juice, due either to a transformation of the pancreatic juice by the admixture of pathological products into a substance which is incapable of being absorbed, or to a loss of function in this direction of the vessels which perform this task.

The obstruction in the pancreatic duct may cause retention and accumulation of pathological products, but can never be the sole cause of retention of pancreatic juice in an otherwise healthy portion of the pancreas. In the cases where normal pancreatic tissue was found in the cyst walls, it was more than probable that the pathological condition which had caused the obstruction did not effect complete physiological detachment of the peripheral portion of the pancreas; in other words, the obstruction was not complete. In cases where complete physiological detachment has taken place, either by the application of a ligature, or complete obliteration of the duct by pathological conditions, parenchymatous degeneration and atrophy in the detached portion are such constant results, that the exceptions to this rule must indeed be few, if any.

In the diagnosis of pancreatic cysts nothing new has been added. The history of the case, the primary starting-point of the tumor in the epigastric region, its gradual and almost painless growth, are points which should be carefully considered in the differential diagnosis of abdominal cysts. The treatment by extirpation, as only recently practised again by Riedel and Billroth, is not deserving of imitation.

The post-mortem examination in Billroth's case shows only too plainly the difficulties met with in identifying the tissues at such great depth, and of avoiding unnecessary injury to important structures. I wish again to repeat what I had to say on this method of treatment last year. Extirpation of the cyst would guard most effectually against the formation of a permanent pancreatic fistula, but, on account of the deep location of the pancreas, shortness or absence of a pedicle, and the many obstacles thrown in the way of the operator by adjacent organs, the procedure becomes one surrounded by innumerable difficulties and, in the present state of our science, of doubtful propriety. The formation of an external pancreatic fistula in the treatment of cysts of the pancreas has been so uniformly successful that it should be invariably adopted in preference to excision, and the latter operation should only be resorted to in cases where portions of the cyst wall have become the seat of malignant disease, likewise in cases where life is threatened by hemorrhage into a cyst by rupture of vessels lining the interior of the cyst, and which cannot be controlled by simpler and less hazardous measures.

XII. Tumors of the Pancreas.

Hypertrophy.

Störck (*Annus Medicus*, 1836; Schmidt's *Jahrbücher*, Supplement Band, 1836, p. 161) mentions a case of intestinal obstruction caused by hypertrophy of the pancreas.

Case I.—A man, forty-eight years of age, previously in good health, had felt a sensation of weight and distress after meals, for more than six months. The flatulency also caused distress, and was relieved

at times by drinking large quantities of water. Bowels constipated. The symptoms of obstruction developed gradually, but finally became so severe that nothing was retained on the stomach. After obstruction had become complete, the patient became collapsed and died two days later. At the autopsy no signs of inflammation or effusion in the peritoneal cavity could be found. The head of the pancreas, which was enlarged to the size of an orange, had so completely compressed the duodenum that its lumen would only permit the passage of a goose quill. Pyloric portion of the stomach was enormously dilated, so that this pouch resembled a kind of lesser stomach. The pancreas was softer, more succulent, and fleshier than normal, but not at all indurated.

Remarks.—As no microscopical examination of the tumor was made, we are unable to classify this case, but considerable doubt must remain whether it was a case of tumor or simple hyperplasia of the gland. The age of the patient and the effect of the tumor upon the duodenum make it quite probable that it was not a case of hypertrophy, but carcinoma or sarcoma. The case illustrates the fact that tumors of the pancreas, when they occupy the head of the organ, are liable to produce intestinal obstruction by compression.

Sarcoma.

Of the malignant tumors of the pancreas, carcinoma is of much greater frequency than sarcoma. Only a very few cases of primary sarcoma of the pancreas are on record.

Case II.—Mayo (*Outlines of Human Pathology*, p. 411) mentions a case of primary sarcoma of the pancreas, with secondary invasion of the stomach, that came under his care. The patient, a man aged thirty-five years, died after an obscure illness which lasted eight months, during which time it was impossible to locate the disease. He dated his illness back to a febrile attack, which left him in a debilitated condition; and from that time he was liable to dyspeptic symptoms, with variable appetite and undefined uneasiness in the epigastric region. A high degree of anæmia was a conspicuous symptom during life. Although the appetite remained good, and digestion did not appear to be very much impaired, emaciation progressed rapidly. On inspec-

tion all the internal parts were found extremely pale, and void of blood; the heart healthy, but nearly empty. The pylorus was thickened and firmer than usual, and had contracted adhesions to the pancreas. The pancreas was considerably enlarged and of nearly cartilaginous hardness, except some spots, which were soft, with the appearance of medullary sarcoma. No other disease could be detected in any other part of the body.

Case III.—Lépine and Cornil ("Contribution à l'anatom. path. du pancréas," *Gaz. Méd. de Paris*, 1874, p. 624) examined the body of a man, sixty-two years of age, who had been sick for eleven months, and had suffered from obstinate vomiting for seven months. The head of the pancreas was found very much enlarged; the remaining portion of it was normal. The small curvature of the stomach was adherent to the tumor, the pyloric orifice thickened and its lumen narrowed. The adhesions involved also the liver, diaphragm, and lower surface of the lung. White metastatic nodules were found in both kidneys. Under the microscope, sections of the tumor revealed a sarcomatous structure.

Remarks.—In the two cases related here, we have the principal types of the clinical behavior of sarcomatous tumors. In the first case the disease involved almost the entire organ, having given rise to extensive local destruction without metastasis; in the second case the disease was limited locally to the head of the pancreas, while it had extended early by contiguity to adjacent organs and by metastasis to distant organs.

Friedreich (Ziemssen's *Cyclopædia*, vol. viii. p. 614) claims that at present we are acquainted with only one single reliable case of primary sarcoma of the pancreas. It is described by Paulick, and was found to be of the small-celled variety; it was taken from the body of a young man who had died of pulmonary and intestinal phthisis. It had not given rise to any noticeable symptoms during life.

Carcinoma.

It is claimed by some pathologists that primary cancer of the pancreas is an exceedingly rare affection, and that in the majority

of cases where this organ is the seat of the lesion it occurs as a secondary affection, having reached it by extension from an adjacent organ, especially from the pyloric extremity of the stomach. While this may be true in many cases, quite a number of specimens have been examined where the disease occurred here as a primary affection. Suche ("De Scirrho pancreat. nonnula," Dissert. Berol., 1834) appears to have examined a specimen which affords a good illustration of primary cancer of the body of the pancreas. The middle of the gland was converted into a hard, irregular, nodulated mass the size of a fist, which rested directly upon the aorta, which imparted to it pulsation during life. When cut into, the tumor grated under the knife, and the cut surfaces presented a laminated appearance. The substance of the tumor was traversed by numerous large veins; both extremities of the pancreas were healthy, and no secondary nodules could be found in any portion of the body. A primary cancer of the pancreas is also described by Schupman (*Hufeland's Journal*, 1841), where the tumor had formed adhesions with the spleen, while the liver contained a number of metastatic deposits. The terminal extremity of the pancreatic duct contained a cylindrical calculus with a number of arborescent projections, which corresponded to the contributory ducts. In another case, reported by Récamier (*Rev. Méd.*, 1830), the cancerous tumor, which involved the tail of the pancreas, was connected with the left kidney and compressed the ureter. The right half of the pancreas was healthy, the diseased portion gray, hard, and lardaceous. The pelvis of the left kidney, in consequence of the compression of the ureter, was hydronephrotic. The remaining organs were healthy.

Bright, in 1832, reported a number of cases of primary carcinoma of the pancreas, with a special view of illustrating the effect which disease of this organ would have upon the digestion of fat. In three out of eight cases he noticed fatty diarrhœa, and he was inclined to the belief that this symptom, when present, is almost pathognomonic of the existence of disease of the pancreas ("Cases and Observations Connected with Disease of the Pancreas," *Medico-Chirurgical Transactions*, vol. xviii. p. 1).

In all cases the fatty diarrhœa was associated with jaundice. The following post-mortem account (p. 17) leaves no doubt that the disease was primarily limited to the pancreas:

"The cause of the pressure on the bile-ducts was immediately obvious; for, on placing the hand near the pylorus, a hard lump, of the size of a common egg, was easily felt, and was soon discovered to be the head of the pancreas itself, and not the glands surrounding that part, forming a yellow mass like the boiled udder of a cow, almost cartilaginous in hardness. Its texture was uniformly hard and unyielding, and the whole pancreas partook of the same, but in a less degree. The head of the pancreas was firmly and inseparably glued to the duodenum, and the hardness very nearly surrounded the viscus."

As undoubted instances of primary cancer of the pancreas, we must mention the published cases of Muehry (*Casper's Wochenschr.*, No. 10, 1835), Albers (*Med. Correspbl. rhein. u. westf. Aerzte*, No 8, 1843), Haldauer (*Assoc. Med. Journ.*, May, 1854), Webb (*Phila. Med. Times*, vol. ii., December, 1871), Gross (*Ibid.*, vol. ii., June, 1872), Luithlen (*Mem. a. d. ærztl. Praxis*, 1872, vol. xvii. p. 309), Roberts (*British Med. Journ.*, Sept. 1865), Wagner (*Archiv d. Heilk.*, vol. ii. p. 285), Bowditch (*Boston Med. and Surg. Journ.*, July, 1872), Davidsohn (*Ueber Krebs der Bauchspeicheldrüse*, Dissert. Berlin., 1872), Williams (*Med. Times and Gaz.*, August, 1852), and Frerichs (*Klin. d. Leberkrankheiten*, vol. i. pp. 146 and 153), as referred to by Friedreich ("Diseases of the Pancreas," *Ziemssen's Cyclopædia*, vol. viii. p. 608).

According to Da Costa (*North Am. Med. Chir. Review*, September, 1858), cancer of the pancreas is more frequent in the male than in the female, and in preference attacks people more than forty years of age. It usually appears as a firm tumor or scirrhus, with a well-developed connective tissue recticulum. Other varieties of carcinoma have been described. Thus, Wagner observed a cylindroma, and Lücke and Klebs have each met with the colloid variety. The primary starting-point is usually in the head of the organ, whence it extends in all directions. By extension within, it successively invades the body and tail

of the organ, until the whole gland is involved, when it forms a nodulated spherical tumor. The extension of the growth in an opposite direction soon reaches the duodenum, where it produces a narrowing or complete stenosis of that portion of the intestinal canal. A case of this kind is related by Hœlscher, where the duodenum was constricted to such an extent that it was entirely impermeable, and the patient suffered for several days from symptoms of intestinal obstruction. While cancer of the stomach is liable to extend to the pancreas, the reverse is not frequently observed. When the carcinoma develops primarily in the pancreatic ducts, it belongs to the variety called cylindroma. The lymphatic glands in the vicinity of the pancreas are invariably affected during the later stages of the disease.

Symptoms and Diagnosis.

Stearrhœa is an important but not infallible symptom of cancer of the pancreas. It is attributed to an absence of the pancreatic juice in the intestinal canal, caused either by obstruction in the duct or suspension of the physiological function of the organ by the neoplastic infiltration. Epigastric pain is an early and important symptom, and is the result of compression of the cœliac plexus by the tumor. The pain often assumes a neuralgic character, and is usually not aggravated after taking food. Vomiting is a frequent symptom, and the matter ejected is generally a watery fluid, sometimes stained with bile. Constipation is an almost constant symptom. Progressive emaciation and anæmia attend malignant disease in any locality, but are unusually well marked in cancer of the pancreas. When the disease extends toward the duodenum, jaundice occurs from stenosis of the bile-ducts by compression or direct invasion by the neoplasm. Bruen has called attention to some forty cases of jaundice due to primary carcinoma of the head of the pancreas, lately reported by another observer, from which it is demonstrated that jaundice is an invariable symptom of primary scirrhus of the head of the pancreas, while it is uncommon when the disease is secondary, or affects the body or tail of the organ.

The most reliable evidence is the appearance of a tumor in the epigastrium behind the stomach. The difficulty of examining the pancreas during health by palpation is appreciated when a physical examination is to be relied upon in locating tumors in this locality. The normal pancreas can be felt only under the most favorable conditions through a thin and relaxed abdominal wall, but in determining its relative size this method of examination affords but little reliable information. A cancer of the pancreas, when it can be felt by palpation, appears in the epigastrium as a hard, immovable or only slightly movable tumor, which is evidently deeply seated in the abdominal cavity. Under favorable conditions the connections of such a tumor with the pancreas can sometimes be demonstrated during life, but a positive diagnosis becomes impossible when, as in most of the cases hitherto recorded, it constitutes merely a part of a general tumefaction of the abdomen. As the tumor is in such close proximity to the abdominal aorta the pulsations of this vessel are imparted to the tumor, and a bruit may even be heard over the compressed vessel; but, in contradistinction to aneurism, the pulsation is felt in only one direction, and the bruit disappears when the patient is placed in the knee-elbow position, as the tumor is lifted from the vessel by the force of gravitation.

That the tumor cannot be always felt is evident from the statement made by Da Costa that he recognized it in only 13 out of the 137 cases he reported; and Bigsby, in an analysis of 15 cases, alludes to its being recognized in only 4.

From what has been said, it will be seen how uncertain the symptoms are in the diagnosis of cancer of the pancreas. A satisfactory conclusion can be reached only after a careful consideration of the history of the case combined with a systematic elucidation of all the symptoms presented, and more particularly by resorting to the advantages to be derived from a systematic and careful study by exclusion.

Treatment.

A positive diagnosis of malignant disease of the pancreas is only possible after the tumor has attained sufficient size to be recognizable by palpation, consequently too late for a radical extirpation. When the disease has advanced to this stage it has already involved the greater portion of the gland and, as a rule, has invaded important adjacent organs. Another important element in the surgical treatment of cancer of the pancreas consists in the fact that the disease, as a rule, develops primarily in the head of the organ, a location which, in itself, precludes the propriety of an operation. The most favorable conditions for extirpation are presented if the disease is primarily located in the tail of the pancreas, and has not passed beyond the limits of the capsule of the gland. In such a case, excision of the splenic extremity of the pancreas would offer a fair prospect for a permanent result without endangering, as a remote consequence, the process of digestion, as a sufficient amount of secreting structure would remain in connection with the intestine to maintain pancreatic digestion.

Billroth, in two instances, made a partial resection of the pancreas in removing carcinomatous tumors of adjacent organs. In one case he removed a portion of the head of the pancreas with a cancer of the pylorus, and in another case he removed the tail of the pancreas with a sarcomatous spleen. Both patients recovered from the immediate effects of the operation. In the case of partial excision of the head of the pancreas it is to be assumed that the duct was not injured, that the organ continued to secrete, and that the pancreatic juice was discharged into the duodenum through the uninjured duct. In operating upon the head of the pancreas for malignant disease which has extended to it from an adjacent organ, it is essential to preserve the continuity of the duct, so as to prevent physiological detachment of the remaining portion of the gland, an accident which would be followed by degeneration and complete atrophy, consequently suspension of pancreatic digestion.

If an operation is performed for cancer of an adjacent organ, and the disease has extended to the splenic extremity of the gland, the operation should not be completed without removing a sufficient portion of the pancreas to guard against a local recurrence of the disease in this organ. As in cases of partial excision of the pancreas for other lesions, the pancreas should be ligated before it is divided, so as to prevent troublesome hemorrhage, and at the same time guard against extravasation of pancreatic juice into the peritoneal cavity.

XIII. Tuberculosis of the Pancreas.

Primary tuberculosis of the pancreas is an exceedingly rare affection; indeed, some pathologists, among them Louis and Lebert, doubt its primary origin in this organ. Cruveilhier only mentions tubercular degeneration of the lymphatic glands upon the surface of the pancreas. In diffuse miliary tuberculosis of the abdominal organs Klebs could find no nodules in the substance of the pancreas on microscopical examination. But in such a condition the gland is often found in a state of parenchymatous degeneration which has been incorrectly interpreted as the first stage of tuberculosis by Ancelet.

When the lymphatic glands around the pancreas have undergone cheesy degeneration we sometimes find similar deposits in the pancreas, which, however, may be cheesy lymphatic glands in the substance of the pancreas itself. Hartmann mentions a case where the pancreas had disappeared completely and its place was occupied by a cheesy mass. Although the pancreas is not disposed to tuberculosis, we have reliable information that in a number of cases this gland was the primary seat of the process.

Case I.—Reported by Aran (*Archiv gén. de Méd.*, 1846). The patient was a woman, twenty-five years of age, who died of a lingering disease. She had been sick for a year, during which time she felt exceedingly weak, had frequent attacks of vomiting, and the skin became deeply bronzed, in some places almost black. The pain,

which was severe at times, was referred to the epigastrium. The necropsy showed a tubercular deposit in the tail of the pancreas the size of a hen's egg, surrounded by a zone of miliary deposits in the substance of the gland. Miliary tubercles were also found in the spleen.

Case II.—Mayo (*Outlines of Human Pathology*, p. 410) describes a case where we have reason to believe that the process commenced primarily in the pancreas. The patient was an inmate of Middlesex Hospital, and was under the care of Dr. Wilson. He was thirty-eight years of age and had been ill for sixteen weeks, during the last seven weeks he was confined to his bed. The first symptoms were pain in the abdomen extending along the right hypochondrium to the spine. Twenty-eight days before death he became jaundiced, stools white, urine high colored; for some time he could lie on the right side only, and was often obliged to sit upright to draw breath. A large abdominal tumor had been felt immediately above the umbilicus some time before death, and the right arm and side of the neck had become œdematous. Autopsy: serous effusion into the right pleural cavity. The gall-bladder was distended to a great size so as to contain eight ounces of fluid. The distention arose from an enlargement of the pancreas, the head of which formed an irregular sphere four inches in diameter, which had compressed the gall-duct; the rest of the gland was likewise enlarged. In parts it presented its natural texture and color, at other parts it was infiltrated with tubercular matter, which at two or three points had softened and formed thick pus. A few lymphatic glands, the thymus gland, and kidneys, appeared to be secondarily involved.

Remarks.—Although in both of these cases the symptoms during life pointed to disease of the pancreas, a sufficiently positive diagnosis to warrant a laparotomy could only have been made after a palpable tumor appeared, and after this time the disease had already passed beyond reach by the appearance of miliary deposits in other organs, an occurrence which would preclude the justifiability of any operative interference. Should abdominal section be performed in a case of tubercular peritonitis, and should such a condition in the pancreas be found as in Aran's case, it would be proper to extirpate the terminal end of the pancreas inclusive of the tubercular abscess.

In Wilson's case the tubercular deposit in the pancreas gave

rise to a large abdominal tumor due partly to the distended gall-bladder, and as such a condition might present itself to the surgeon, in these days of diagnostitial laparotomy, it might be advisable, and to the advantage of the patient, to establish an external pancreatic fistula instead of closing the wound. Such a course would enable the surgeon to remove the cheesy material, disinfect the abscess cavity, and to treat its interior with iodoform, all of which, done under antiseptic precautions, would tend to modify favorably the local process.

The removal of compression of the bile-duct by the same procedure would also tend to reëstablish the interrupted communication between the bile-ducts and the duodenum by removing the cause of the stenosis.

XIV. Lipomatosis of the Pancreas.

Lipomatosis, or fatty infiltration of the pancreas, is a pathological condition of this organ which is characterized by a transformation of the interacinous connective tissue into fat in contradistinction to fatty degeneration of the parenchyma cells, which sometimes occurs as an independent affection. In cases of fatty infiltration the shape and size of the pancreas may remain normal, but the secreting structures themselves may have completely disappeared by pressure-atrophy. This disease is of little interest to the surgeon, except that it may serve as a predisposing cause of interstitial hemorrhage, in which connection it has already received mention ; it is here again alluded to as a separate affection to demonstrate that gradual atrophy of the pancreas, even to the extent of complete disappearance of the glandular structures, may occur without causing serious impairment of the digestion. Rokitansky (*Lehrbuch der path. Anat.*, vol. iii. pp. 313 and 369) has found this condition of the pancreas generally as a part and parcel of a general obesity, especially in intemperate persons, together with fatty liver, heart, and omentum. In the three cases of pancreatic apoplexy described by Zenker, the fatty infiltration of the pancreas was only one of the

many evidences of a diffuse malnutrition of the tissues. In some of these cases the patients exhibited no symptoms during life indicating the absence of the pancreatic secretion, and yet on making the post-mortem examinations complete destruction of the glandular structure was found.

Litten (*Charité Annalen*, 1881) has reported three cases of complete atrophy of the pancreas in which, during life, no symptom of pancreatic disease was observed, such as fatty stools, salivation, lipuria, bronzed skin, cœliac neuralgia, etc. In two cases the atrophy was due to pressure, and in one instance it was caused by primary cancer of the pancreas.

In other cases the suspension of the pancreatic function by fatty degeneration of the organ produces well-marked symptoms during life, and may even result in death. Such a case is reported by Lépine and Cornil (*Gaz. Méd. de Paris*, p. 624). The patient was a drunkard, fifty-seven years of age. For six months he had been ailing with indigestion, marked loss of weight, diarrhœa alternating with constipation, no fever, no vomiting. For two months his body was covered with an eruption, and his feet became œdematous. At the autopsy the pancreas was found normal in size and shape, but the parenchyma of the gland had entirely disappeared, and its place was occupied by adipose tissue. The pancreatic ducts were filled with a viscid whitish fluid and small concretions. No other cause of death could be found in any of the remaining organs. Clinical observation appears to confirm the results obtained by experiments on animals, that in some instances complete gradual atrophy of the pancreas is compatible with normal digestion, while, in other cases, the suspension of the pancreatic secretion is followed by serious disturbance of digestion, marasmus, and death from inanition.

The only plausible explanation of the different effects of the same cause can be found in the supposition that in some individuals the compensating function of vicarious organs maintains normal digestion, while in others no such compensating action is established.

XV. Lithiasis of Pancreatic Ducts.

Concretions of carbonate and phosphate of lime are frequently found in the pancreatic ducts. They are usually multiple, small, whitish, smooth, or of rough and irregular shape. Calculi in this locality have been found which measure more than an inch in diameter. In Shupmann's case, the calculus weighed 200 grains and measured one and a half Paris inches in length, and from five to six Paris lines in diameter; having a crystalline surface, with processes running into smaller ducts. It was found in the left extremity of Wirsung's duct.

Sometimes the concretions of calcium phosphate and carbonate exist in cases of incrustation of the mucous lining of the ducts. According to Collard de Martigny, the calculous concretion is sometimes composed of phosphate of lime alone. The calculi in this locality are usually solid formations, of fine granular structure with somewhat rough surfaces and very often covered with sharp points of projection. In some specimens the stone presents numerous branches which correspond to smaller pancreatic ducts. The irritation incident to the presence of a calculus in the pancreatic duct is followed by consecutive pathological changes in the duct and glandular tissue of the organ itself. The substance of the organ in the immediate vicinity of the stone becomes the seat of interstitial inflammation, followed by atrophy and sclerosis; the cicatricial tissue produced by this change causes contraction, an occurrence which may still further aggravate the obstruction. In some instances this inflammatory process does not remain localized, but extends over the entire gland, as in the cases observed by Engel, Elliotson, and Curnow. In some cases the concretion gives rise to suppuration, as in Portal's case. His patient had died suddenly with symptoms of aneurism of the aorta, and at the autopsy an abscess was found in the head of the pancreas which contained a number of biliary and pancreatic calculi. In Fauconneau-Dufresné's case, as quoted by Ancelet, the left half of the pancreas contained a number of abscesses, one of which had perforated into the

stomach. The pus contained numerous concretions varying in size from that of a pin's head to that of a bean. Salmade observed a case of lithiasis complicated with abscess of the pancreas, where the swelling compressed the underlying aorta to such an extent that death was produced by the rupturing of a vessel from over-distention on the proximal side of the obstruction.

Mr. Moore (*Lancet*, Jan. 12, 1884) presented to the Pathological Society of London the pancreas of a man, aged forty-three years, who died in St. Bartholomew's Hospital of an attack of pleurisy following gouty symptoms. The main duct of the organ was dilated and contained a calculus of irregular shape, around which was a large abscess in the head of the organ. This abscess pressed upon the orifice of the bile-duct sufficiently to produce great distention of the gall-bladder. A number of cases of cysts of the pancreas have been reported in connection with a calculus in the duct on the proximal side of the cyst, and in which the dilatation of the duct was attributed to obstruction due to the presence of the foreign body in the duct. Complete stenosis of the pancreatic duct, due to intrinsic or extrinsic causes, is always followed by parenchymatous degeneration of the glandular tissue on the peripheral side of the seat of obstruction, which necessarily arrests the physiological function in that portion of the organ, hence we are unable to explain the retention of the secretion from this cause unless impaction of the calculus takes place suddenly. Again, assuming this to be the case, we know that healthy pancreatic tissue will remove its own secretion by absorption in case of sudden stenosis or obstruction of the duct. We are, therefore, forced to explain the occurrence of a pancreatic cyst in the course of gradual or sudden obstruction of the ducts by a calculus, cicatricial or malignant stenosis, to parenchymatous changes in the peripheral portion of the gland rather than to the obstruction. This argument, of course, applies only to the so-called retention cyst. Simple, uncomplicated obstruction of the duct may give rise to accumulation of pathological products which under no circumstances are amen-

able to removal by absorption. The former assertion is well illustrated by the specimen referred to above which Norman Moore (*Lancet*, Jan. 12, 1884) exhibited before the Pathological Society of London, which showed great dilatation of the common pancreatic duct throughout its entire length. Near the orifice the duct was obstructed by a small calculus of irregular shape. The whole gland was hard, and to the naked eye showed a condition of advanced connective tissue hyperplasia. The papilla in the duodenum was enlarged and the hardened tissue of the pancreas constricted the bile-duct so as to cause complete obstruction. The liver showed secondary changes due to the stasis of bile. A microscopical examination of the specimen showed it to be a case of genuine cirrhosis of the pancreas, only a small number of acini remaining in healthy condition. In this case the cirrhotic change in the organ was undoubtedly produced in the same manner as by constriction of the duct as practised in the experiments on animals, the first link in the chain of pathological changes being the mechanical obstruction of the duct by the calculus.

Symptoms and Diagnosis.

A positive diagnosis of pancreatic lithiasis during life is impossible. Calculi and concretions have been found at post-mortem examinations of persons who, during life, did not suffer from any symptoms indicating the existence of such conditions. Pain, fatty stools, hæmatemesis, diabetes, are symptoms sometimes associated with this lesion of the pancreas, but when present they point rather to the existence of a consecutive lesion of the substance of the gland produced by the calculus than to the presence of the calculus itself. If the calculus be arrested at the outlet of Wirsung's duct it may, at the same time, obstruct the outlet of the bile by compressing the ductus choledochus and so cause jaundice. But the same effect can also be produced by cirrhosis of the head of the pancreas, with or without the presence of a calculus in the pancreatic duct. Mr. Morris claims that he has seen cases of pancreatic stone colic, but in

such cases it would be impossible to differentiate between the passage of a biliary and a pancreatic calculus along their respective ducts, as a biliary calculus may obstruct the common pancreatic duct and *vice versâ*.

Treatment.

As the diagnosis of a calculus of the pancreas, *intra vitam*, is impossible, the surgical treatment must be limited to the management of some of its consecutive lesions—cysts, abscess, and retention of bile.

The treatment of cystic disease and abscess of the pancreas has been considered under their respective headings, and I will only add that when these conditions have been caused by an impacted calculus, an effort should be made to recognize the primary cause and, if possible, to remove it. As the surgical treatment of retention of bile due to the mechanical obstruction of the biliary passages is now receiving much attention on the part of surgeons, it is well, in this connection, to call attention to impaction of a pancreatic calculus in the duodenal portion of the pancreatic duct as an occasional cause of obstinate jaundice. If, in a case of this kind, abdominal section should reveal the true nature of the obstruction, an effort should be made at the time to force the calculus into the duodenum by taxis, and if this cannot be accomplished, the propriety of cutting for the stone should be carefully considered. As an impacted calculus in this locality not only endangers the life of the patient by cholæmia, but may also destroy life suddenly by perforation into the peritoneal cavity, it would be not only justifiable but good treatment to remove it after a positive diagnosis has been made by means of diagnostitial laparotomy. The greatest danger attending such a procedure would be extravasation of bile into the peritoneal cavity. This accident should be guarded against by removing the retained bile by aspirating the dilated bile-ducts as a preliminary measure. After extraction of the stone the incision in the duct should be accurately closed with fine silk sutures. The secretion of bile and pancreatic juice should

be reduced to a minimum after the operation by keeping the digestive organs in a condition of absolute physiological rest during the time required for the healing of the visceral wound.

In conclusion, I beg leave to submit for your further consideration and discussion the following propositions:

1. Restoration of the continuity of the pancreatic duct does not take place after complete section of the pancreas.

2. Complete extirpation of the pancreas is invariably followed by death, produced either by the traumatism or gangrene of the duodenum.

3. Partial excision of the pancreas for injury or disease is a feasible and justifiable surgical procedure.

4. Complete obstruction of the pancreatic duct, uncomplicated by pathological conditions of the parenchyma of the organ, never results in the formation of a cyst.

5. In simple obstruction of the pancreatic duct, the pancreatic juice is removed by absorption.

6. Gradual atrophy of the pancreas from nutritive or degenerative changes of the secreting structure is not incompatible with health.

7. Physiological detachment of any portion of the pancreas is invariably followed by progressive degeneration and atrophy of the glandular tissue.

8. Extravasation of fresh normal pancreatic juice into the peritoneal cavity does not produce peritonitis, but is promptly removed by absorption.

9. Crushed or lacerated pancreatic tissue is removed by absorption, provided the site of operation remains aseptic.

10. Complete division of the pancreas by elastic constriction is never followed by restoration of interrupted anatomical continuities.

11. Limited detachment of the mesentery from the duodenum, as required in operations upon the pancreas, is not followed by gangrene of the bowel.

12. In all operations upon the head of the pancreas, the physiological connection of the peripheral portion of the gland

should be maintained by preserving the integrity of the main pancreatic duct.

13. Partial excision of the splenic portion of the pancreas is indicated in cases of circumscribed abscess and malignant tumors, in all cases where the pathological product can be removed completely without danger of compromising pancreatic digestion or inflicting additional injury upon important adjacent organs.

14. Ligation of the pancreas at the point or points of section should precede extirpation as a prophylactic measure against troublesome hemorrhage and extravasation of pancreatic juice into the peritoneal cavity.

15. The formation of an external pancreatic fistula by abdominal section is indicated in the treatment of cysts, abscesses, gangrene, and hemorrhage of the pancreas due to local causes.

16. Abdominal section and lumbar drainage are indicated in cases of abscess or gangrene of the pancreas where it is found impossible to establish an anterior abdominal fistula.

17. Through drainage is indicated in cases of abscess and gangrene of the pancreas, with diffuse burrowing of pus in the retroperitoneal space.

18. Removal of an impacted pancreatic calculus in the duodenal extremity of the duct of Wirsung, by taxis or incision and extraction, should be practised in all cases where the common bile-duct is compressed or obstructed by the calculus and death is threatened by cholæmia.

19. In such cases the principal source of danger, extravasation of bile into the peritoneal cavity, should be avoided by preliminary aspiration of the dilated bile-ducts, accurate closure of the visceral wound with fine silk sutures, and absolute physiological rest of the organs of digestion during the time required in the healing of the visceral wound.

DISCUSSION.

Dr. P. S. Conner, of Cincinnati.

I am sure that I voice the sentiment of all the Fellows, when I express my high admiration for the paper just read, for its thoroughness, characteristic of its author, and for the extent of the field gone over by him in the experiments described. At the same time, I feel that possibly an unfair advantage has been taken of me in asking me to discuss this paper, unless it be that we can discuss with the greatest ease those subjects of which we know least. I shall look forward with pleasure to the appearance of the volume in which the whole paper is presented, for, remembering the papers that have preceded this, I am sure that a much more definite idea of the subject of this one will be present in my mind after reading the paper in its entirety. Of this subject I now know but little, and I think that we owe a great deal to him who has just presented something positive with reference to questions on which but little light has heretofore been shed, who has confirmed the experiments of others and supplemented them by original ones which have thrown much light upon disputed points.

Of the surgery of the pancreas little can be known, for the reason that the cases are often difficult of recognition, and until the diagnosis is clearly established, no operative procedure can be properly entered upon. If I were asked to-day to consider a case of pancreatic disease, I should scarcely know anything more about it than I did before, and should not until I had had an opportunity of reading what has been presented in brief to-day. At the same time, certain facts of interest have been given us—*e. g.*, the points with reference to the atrophy of the gland, the absence of necessity of removing portions of the gland, the danger of leaving any portion of the devitalized organ, and the proper treatment of cysts.

In introducing the discussion, I can only express my appreciation of the great labor that has been undergone and the thoroughness with which every point has been touched upon, which are so characteristic of all the writer's work.

Dr. Christian Fenger, of Chicago.

It is with the greatest admiration that I have listened to the interesting paper of Dr. Senn, and I have nothing to say either as a correction

or as an addition. The treatment of the subject is too complete for that. I only wish to mention a clinical observation, because it confirms the physiological experiments of the author of "Occlusion of the Pancreatic Duct," some of whose experiments I have had the pleasure of personally witnessing.

This observation shows that a carcinoma of the head of the pancreas, occluding the main duct near its outlet, has caused complete atrophy of the whole gland, and a slight rosary-shaped distortion of the distal portion of the duct, but no cystic formation peripheral to the obstruction. I shall exhibit two drawings.

FIG. 1.

Fig. 1 shows the carcinoma in the head of the organ and surrounding the pancreatic duct and the bile-duct, both of which are seen distended distal to the tumor.

Fig. 2 shows a microscopic section of the border of the tumor. In the lower portion of the field is the tissue of the carcinoma; in the upper portion, the atrophied tissue of the pancreas with its empty granular stroma, from which all the parenchyma cells have completely disappeared.

These drawings show cylindrical epithelial carcinoma in the head of the pancreas, one and a half inches long and three-fourths of an inch broad. Compression of the central portion of the pancreatic duct,

FIG. 2.

leading to dilatation of its distal portion and atrophy of the gland, this ectasis not exceeding five to six millimetres in diameter. A small secondary tumor at the junction of the head and tail of the pancreas. Compression of the central portion of the bile-duct, with considerable dilatation of the latter above the point of stricture, icterus, colæmia, death.

At my request Dr. Hall, son of the patient from whom the specimen was taken, kindly furnished me with the following history:

"David A. Hall, aged fifty-six, American, born in Indiana, live stock commission merchant. Had not been sick for thirty-six years.

"Began feeling weak about July, 1885, and in October, 1885, he had severe colicky pains after eating a full meal, or after eating certain articles, among these, oranges.

'On November 16, 1885, he had to take to his bed. He had at that time considerable weakness, pain in the pit of the stomach nearly constant, but somewhat worse after a full meal or after certain articles of diet. The pain sometimes amounted to colic. Bowels constipated, appetite not as good as usual. No tenderness of the abdomen. Some tympany.

"One month later, December 17th, he took a journey of one hundred miles in the country and upon returning he had to go back to his bed again. The pain now gradually moved from the pit of the stomach toward the left side and by February 1st had descended to the left iliac region. Just before death it appeared to be most intense in the pubic region. It was paroxysmal and colicky. Patient laid invariably on his right side, as any other position increased the pain.

"Jaundice appeared about January 10th. The urine contained much bile pigment. The skin was a deep yellow. The stools were white, soft, and irregular, a large soft stool occurring every three or four days. A little later the stools were noticed to contain much oil that floated off on water, though very little fatty matter was ingested at the time. On the occurrence of jaundice there was a little fever for a few days and some tenderness in the right hypochondriac region. There was no subsequent fever or tenderness.

"Dr. Fenger at this time diagnosticated cancer of the head of the pancreas.

"There was great pruritus of the skin. Emaciation was very rapid. Much gas was evolved from decomposition of the intestinal contents, causing tympany and colic. There was no diarrhœa or vomiting. Some mental disturbance occurred a week, and coma a day and a half before death. The tongue was lightly coated with a white fur throughout the sickness.

"There is no history of cancer in the family."

When I first saw the patient on January 18th, in consultation with Dr. Hall, Dr. Charles Gillman Smith, and Prof. Roler, I found the following conditions:

Patient was in bed, moderately emaciated. Skin and conjunctivæ jaundiced. Extreme and paroxysmal pains in the abdomen made him submit reluctantly to a thorough examination. I found lungs and heart normal. Pulse 80, temperature 98.5°. Abdomen soft. Adipose tissue in parietes medium in quantity. Hepatic dulness, of normal dimensions upward, and reaching one and a half inches below the hypochondrium. No particular tenderness over the liver, the surface of which was smooth. No enlargement of the gall-bladder. Moderate tenderness near the cardiac on deep pressure, but no distention or hardness here. Above the umbilicus the abdominal aorta could be felt pulsating normally. On deep respiration, no moving resistance could be felt over or below the stomach. There was no enlargement of the spleen. No ascites. He complained of pain in the left hypo-

gastric, iliac, and suprapubic regions, but in none of these places could any resistance be detected by palpation. Nor was there any tenderness upon pressure. Examination through the rectum did not reveal anything abnormal. There was no œdema of the lower extremities.

From the course of the disease, indigestion without any symptoms of carcinoma of the stomach, pain in the cardiac and later lower down in the abdomen, absence of any palpable tumor, persistence of symptoms, progressive emaciation and weakness, and finally jaundice, I concluded that a constriction of the bile-duct had taken place somewhere between the gall-bladder and the duodenum, probably from a malignant tumor.

The most likely seat of this tumor I placed in the head of the pancreas. This would correspond to the original seat of pain and explain the icterus in the subsequent stage of the disease.

I saw the patient again February 2d and found no material change in his condition, except increasing weakness. This, and the undigested oily stools, seemed to confirm the previous diagnosis.

March 5th the patient died after a premonitory cholæmic stage. On March 6th an autopsy was made by Dr. Bischoff in the presence of Dr. Charles Gillman Smith, Dr. Bernauen, and myself.

The body was somewhat but not extremely emaciated. There was no œdema. The skin and subcutaneous tissue were jaundiced. The abdominal cavity alone was opened. In the peritoneal cavity, which was healthy, there was no fluid. The liver was somewhat larger than normal and of a dark greenish-brown color. The gall-bladder was somewhat distended, but the common bile-duct and its hepatic branches were much dilated and filled with dark green bile. The pancreas was removed in connection with the duodenum and the pyloric portion of the stomach. About the head of the pancreas, which felt somewhat hard and enlarged, there were connective tissue adhesions to the two opposite layers of the bursa omentalis, viz., the peritoneal covering on the anterior surface of the head of the pancreas and the posterior peritoneal surface of the ligamentum gastro-colicum. The body and tail of the pancreas felt soft and flabby, except a small hard nodule at the junction of the head and tail. The spleen, kidneys, and remainder of the intestines were normal. The bowels contained a moderate amount of colorless mucus and feces.

Examination of the removed pancreas and its adnexa revealed the following:

The duodenum contained some grayish-white mucous matter with no color of bile. The diverticulum vateri was of normal shape and size,

and no tumor or hardness was found in the intestines. The opening of the diverticulum was normal, and pressure from above expelled colorless mucus but no pancreatic fluid. In the head of the pancreas was a hard nodule, one and a half inches long by three-quarters of an inch broad, through which the common bile-duct and the main pancreatic duct passed, and by which both ducts were compressed but not perfectly occluded. It was possible to pass a very fine probe through both of these ducts. Above the tumor the bile-duct was suddenly dilated and distended with dark green bile. The pancreatic duct above the tumor and in the body of the gland was interruptedly dilated, exhibiting a varicose or rosary-like appearance, the dilatations having a diameter of three to five millimetres; they were filled with a clear mucous fluid. There was no cystic formation to be seen. The pancreatic tissue surrounding the duct was flabby and atrophic, feeling like loose connective tissue or atrophic adipose tissue, and hardly discernible from the surrounding connective tissue. The whole pancreas was five inches long, three-quarters of an inch broad, and only one-quarter of an inch thick.

The microscopic examination showed the following:

The hard mass in the head of the pancreas as well as the nodule in the body presented the well-known appearance of cylindrical-celled epithelial carcinoma with irregular bodies and cavities of all possible sizes lined with cylindrical cells, with no basal membrane, and surrounded with or embedded in a connective tissue that was partially infiltrated with numerous embryonal cells.

The surrounding flabby tissue of the pancreas showed everywhere the connective tissue stroma of the gland, perfectly empty, not containing even one of the parenchymal cells of the gland, the uniform round or cuboid spaces looking somewhat like adipose tissue from which the cells have been brushed away. This connective tissue stroma showed no thickening or proliferation of the cells; in other words, it showed a simple atrophy of the glandular tissue, with disappearance of the secreting cells not accompanied or caused by any inflammatory process.

Dr. Charles T. Parkes, of Chicago.

I desire to express my appreciation and admiration of this paper. I feel particularly concerned in it because Dr. Senn's experiments confirm the results of some experiments which I have performed myself.

These experiments resulted fatally, usually in consequence of a devitalized portion of tissue remaining in the abdominal cavity. They also show the danger of the separation of a large portion of the mesentery from the intestines.

Dr. Senn. I simply rise to express my sincere thanks to the Fellows for the manner in which they have received my work on previous occasions and the attention which they have given to this paper.

TRAUMATIC ANEURISM OF INTERNAL CAROTID ARTERY FOLLOWING GUNSHOT INJURY.

By T. F. PREWITT, M.D.,
PROFESSOR OF SURGERY IN THE MISSOURI MEDICAL COLLEGE, ST. LOUIS.

Since the days of John Hunter, the subject of aneurism has possessed a peculiar interest to surgeons, and especially to English-speaking surgeons.

The advanced position which the new application of the ligature in the treatment of aneurism—perhaps the most brilliant surgical discovery of the last century—gave to British surgery in this direction, has been maintained to this day. Sir Astley Cooper first availed himself of the Hunterian method in the treatment of aneurism of the carotid, the Irish surgeons introduced compression, Syme revived and improved the old operation, while Mr. T. Holmes is perhaps the highest authority upon the subject of aneurism at this day.

Anything bearing upon the subject of aneurism, and especially of carotid aneurism, I am sure will not be lacking in interest to a body of American surgeons. What I have to say, however, is limited to that portion of the artery least subject to disease, least exposed to injury, and least accessible to operation—the internal carotid artery external to the carotid foramen.

In 1842, Mr. Syme, speaking of spontaneous aneurisms, declared that "aneurism of internal carotid external to cranium does not seem to have been ascertained or recorded."[1]

Some of the latest standard authorities ignore it entirely in discussing the subject of carotid aneurism, while others speak of the possibility of its occurrence.

[1] J. M. Syme, London and Edinburgh Monthly, 1842, vol. ii.

Holmes, in the article on "Aneurism" in his *System of Surgery*, utterly ignores it. He says that "aneurism above the root of the neck will be found to affect either the common carotid just at its bifurcation or the arteries of the orbit or cranium.

Ashhurst alludes to it incidentally.

Agnew states that the internal carotid may be the subject of aneurism in its *cervical*, *petrous*, and intracranial portions.

Erichsen does not mention it.

Gross refers to it as having occurred in a few instances.

Bryant makes no mention of it.

Gant disposes of the subject in twenty lines.

Yet scattered through the medical literature of the last half century are a few cases of aneurism of this artery. The second case in which Sir Astley Cooper ligated the common carotid for aneurism—his first successful case—he regarded as one of aneurism of the internal carotid. Yet there might reasonably be a doubt as to the correctness of the diagnosis, since the tumor "projected outward, was the size of a walnut, extended from the angle of the jaw downward to the thyroid cartilage, and was prominent in its middle." No mention is made of any projection into the pharynx. We could scarcely conceive of an aneurism of the internal carotid not larger than a walnut, yet which projected outward to a marked degree, but did *not* project inward.

Other cases have been reported by Syme: *London and Edinburgh Monthly Journ. Med. Science*, November, 1842. L. Meyer: *Arch. f. Psychiatr.*, 1875. Duke: *Dublin Med. Press*, 1848. Neuffer: *Zeitschrift f. Wundärzte u. Geburtsh.*, 1851. Patterson: *Edinburgh Med. Journal*, 1859. Perier: *Rec. de Mém. de Méd. Mil.*, Paris, 1854. Pircher: *Wien. med. Wochenschrift*, 1862.

The rarity with which we meet with aneurism in this artery is explained by its almost complete exemption from the degenerative changes which affect arteries in other portions of the body.

When we come to the question of traumatic aneurism, I have been able to find upon record but a single case—that of our distinguished Fellow and ex-president, Dr. W. T. Briggs, of Nashville. This was the result of an incised wound, and was

operated upon by Dr. Briggs successfully in 1871—the condition being such as to permit a ligature of the internal carotid.

In consequence of the sheltered position and great depth of this vessel it is rarely wounded, and, when this is the case, the accident is usually rapidly fatal.

I have not been able to find upon record in any of the literature accessible to me, any reference to gunshot injury of the internal carotid followed by aneurism. It is true that Scarpa says

"Acrell gives the account of an aneurism, which he calls *true*, of the left internal carotid artery caused by a wound of a musket-shot, in which the ball entered on the anterior side of the neck between the trachea and the trunk of the left carotid.

"This aneurism, by means of a graduated compression, gradually diminished, so that the artery at the end of six months had, according to the opinion of the author, reacquired its strength and natural diameter."

But Scarpa further says,

"What seems probably to have been the fact in this case is, that a coagulum had formed, and that it having stopped the effusion of blood, had allowed the lymphatic system to absorb that portion of the blood which had been before extravasated, and which formed the bulk of the tumor."[1]

The case I have the honor to report to this Association, therefore, seems without a counterpart in the annals of Surgery.

Eliza Jewel, colored, aged seventeen, was shot by her husband in the latter part of December, 1884, or January 1, 1885, the weapon used being a revolver carrying a ball of thirty-two calibre. At the moment of firing, he stood about two feet distant from her and a little to her right. The bullet entered the cheek over the malar bone, a little anterior to its junction with the zygoma, ranging backward. The shot was followed by immediate and profuse hemorrhage from the wound of entrance, there being no wound of exit. This was controlled by compression. Patient also stated that hemorrhage took place from

[1] A Treatise on the Anatomy, Pathology, and Surgical Treatment of Aneurisms. By Antonio Scarpa. Page 381.

her ear at the time of shooting and recurred two or three times afterward. She also stated that for one week after the shooting she bled from the mouth and nose, upon rising in the morning. Some swelling occurred immediately between the ramus of the jaw and mastoid process.

This swelling grew larger and larger, until—April 2, 1885—it projected into the pharyngeal cavity, crowding the tonsil over to the median line and resting against the uvula. Externally it extended from the inferior surface of the petrous portion of the temporal bone above, to the level of the hyoid bone below. The tumor pulsated in every direction, and had a marked aneurismal "bruit" and thrill. The walls of the sac seemed thin, especially upon the pharyngeal side.

Immediately after the shooting there was paralysis of the pharyngeal muscles of the right side, and the patient lost the sense of taste upon the right side of the tongue, which, when projected, inclined to the right. It was somewhat atrophied and deeply corrugated or furrowed upon this side.

Pressure upon the common carotid arrested pulsation in the tumor, and caused it to decrease somewhat in size. There was no perceptible difference in pulsation in the right and left temporal arteries. No difference in size of pupils, which responded normally. Pain had increased of late and was "needle-like in character. She had persistent headache. Ever since the shooting there had been a roaring in the right ear, if she lay upon that side. Her voice was greatly impaired, due in great part to paralysis of the right vocal cord. Her appetite was not good, and she was somewhat emaciated. She was unable to swallow meats and solids generally. Ever since the injury, fluid regurgitated when the patient swallowed. The tumor had the marked expansile pulsation of aneurism, both in the throat and externally.

With this history and the symptoms present, I had no hesitation in deciding that I had a case of aneurism of the internal carotid artery to deal with, and that this vessel had been injured by the bullet close to its exit from the carotid foramen. In view of the large size of the sac and the threatening aspect it presented, I decided to ligate the common carotid artery at once.

This I proceeded to do on April 4, 1885, assisted by Dr. A. L. Brokaw, Prof. H. Tuholske, and others. After anæsthetizing the patient the usual incision was made, and the dissection continued until the artery was exposed. Passing a silk ligature under it from behind forward just above the belly of the omohyoid, carefully avoiding the

pneumogastric nerve, the ligature was pulled upon and the vessel lifted up, to be sure that the pulsation was arrested before ligating it. Having satisfied myself of this, the vessel was finally tied. The pulsation and thrill seemed arrested at first, but in a few minutes they could again be felt in the sac and it was feared the operation would prove a failure. In the absence of all precedents, I decided, with the concurrence of Prof. Tuholske as a forlorn-hope, to extend the incision upward in front of the tragus to determine the feasibility of laying open the sac and tying upon the distal side of it. I say a forlorn-hope, because my diagnosis had placed the opening of the sac close to the carotid foramen. Here, at least, the dictum of Mr. Syme that "in every aneurism, whether large or small, traumatic or spontaneous, the aperture of the artery is situated toward the centre of the tumor," could not be relied upon.[1]

To facilitate the dissection, an incision slightly oblique was made from a point below the lobe of the ear, upward and backward behind the ear. A cautious dissection at the back and upper part of the sac revealed the fact that the sac filled all the space between the mastoid process behind, and the condyle and ramus of the jaw in front, extending upward to the base of the skull—the sac, in fact, seeming *to blend with the skull*, or to be closely adherent to it. It was, therefore, impossible to reach the trunk of the artery from that direction. A little reflection made it apparent that any attempt to deal with the sac after the method of Mr. Syme would, in all probability, prove disastrous, as it would almost certainly be found that there was no portion of the artery between the carotid foramen and the sac to be tied.

Any further attempt was therefore abandoned; the wound was washed with a bichloride solution (1 : 1000), a drainage tube placed in its lower portion, the edges drawn together with silk sutures, and antiseptic dressings applied. In the dissection, a minute wound of the jugular vein was made, just where it is crossed by the spinal accessory nerve, but this nerve laid over the little opening would stop all bleeding, which would immediately recur when the nerve was drawn aside. It was thought unnecessary to do anything to close the opening beyond placing the nerve on guard.

On the next day, April 5th, the patient complained a good deal of soreness and difficulty in swallowing, and had some fever. On the 7th

[1] Quoted by Holmes, Surgical Treatment of Aneurism, Lancet, 1873.

(fourth day), the temperature reached 101¾° F., and the wound was suppurating freely. The swelling seemed a little larger than the day before, and she said the noise in her head continued.

On April 9th, temp. 102⅗° F., pulse 120.

The temperature varied for the next three days from 102° F. to 102⅘° F. On the night of the 12th, the eighth day after operation, hemorrhage occurred from the external wall of the sac, though not to an alarming extent. Her mother also stated that she had been spitting up some blood. The next day (13th) hemorrhage recurred, and on examination its source was found to be from the sac at a point nearly opposite the angle of the jaw. A coagulum partially blocked the bleeding point. This was removed, the opening cautiously enlarged, and my left forefinger thrust into it, very little blood escaping. I could detect no trace of coagulum in the sac. I then commenced a search for the opening in the artery, or the carotid foramen. Repeated experiments to determine the success of my efforts in this direction proved unsatisfactory, and I was convinced that the laying open of the sac or the removal of my finger was likely to be followed by a speedily fatal hemorrhage—by no means a pleasant predicament in which to find one's self. In my search I could feel what I believed to be the bullet embedded in the posterior part of the sac. I directed my assistant to cut several strips of lint, had them thoroughly rolled in iodoform, and proceeded to crowd them into the sac beside my finger, until it was completely packed.

I had the gratification of finding that this completely controlled all bleeding. Next day, April 14th, the temperature had fallen to 101° F., but the pulse was 132. In the meantime the patient was becoming weaker and more emaciated. She could be induced to take very little nourishment; she declared that she could not swallow.

During the next seven days the temperature ranged from 101⅗° F. to 102⅕° F. The lowest recorded point was 101° F. on the 18th, the highest 103° F. on the 17th; while the pulse varied from 122 to 128. April 22d, the temperature fell to 99⅖°, and did not rise above this until her death, from exhaustion, which occurred on the 29th, at 4.30 P. M., just twenty-five days after the operation

It will be seen that a septic fever had supervened, although a good deal of care had been exercised from the outset to prevent it. There were no indications of suppuration of the sac, which had continued to pulsate up to the time of the occurrence of the secondary hemorrhage. Epileptiform convulsions set in on the 23d, ten days after the tenting

of the sac, and involved the facial muscles and the flexors of the arms and hands. These continued at intervals until her death—that is, during a period of about six days. Up to the occurrence of the convulsions no cerebral symptoms had been observed that could be regarded as due to the ligature of the common carotid. The body was taken in charge by the coroner and a partial post-mortem made before I was notified—to my great regret. The sac had been laid open and the lint removed. The bullet also, which had lodged in the posterior part of the sac, partially embedded in the bone, had been extracted. Its exact position is a little uncertain, but the presence of two small fragments of bone, probably carried forward by the bullet, would indicate that it had lodged in the condyle or transverse process of the atlas. Continuing the dissection, the bullet was found to have passed through the zygoma near its junction with the zygomatic process of the malar, fracturing the coronoid process of the lower jaw, passing downward and backward to its point of lodgement. The course of the ball could be readily traced by the dark stain along its track. The opening of the artery was found, as had been predicted by me, close to the carotid foramen, which seemed blocked by a clot. The internal jugular vein, seemingly intact, appeared to be completely blocked. On removing the calvarium and meninges the bloodvessels were found full and congested, those upon the right side markedly so. The right inferior petrosal and lateral sinuses were filled with thrombus, the latter to a point beyond the torcular Herophili.

The post-mortem was made under very trying circumstances, while a number of witnesses were yet waiting outside to identify the body and testify in the case. With these surroundings the head was literally resected, and the scalp and integuments of the face and neck skilfully stuffed by my assistant, Dr. A. V. L. Brokaw, to present the needed resemblance to enable the witnesses to recognize and identify the body. It can be readily understood that the opportunity to study the parts at leisure was not good.

The normal appearances of the parts had been greatly altered by the changes which ensued upon the packing of the sac. This had evidently arrested the venous return in the internal jugular.

While this case unfortunately proved fatal, it is believed that the interest and instruction connected with it are not to be measured by the result, but that it presents many points quite as interesting as if it had proved successful. So rarely has

aneurism of the internal carotid been met with that our standard authors speak of it only from the reports of others, not from personal observation. The methods of diagnosis are not always clearly defined, and doubtless the diagnosis is often difficult.

The differential diagnosis as between tumors of this region and aneurism of the internal carotid, is to be determined upon the same principles that guide us in suspected aneurism in other portions of the carotid system. The liability to error would be greatest in the direction of abscess about the tonsil or neck. This error has occurred in relation both to the common and internal carotid. In the celebrated case of Mr. Liston, of aneurism of the common carotid, brought before the Medico-Chirurgical Society of London, under the title of a "Variety of False Aneurism," Mr. Bransby Cooper, in the discussion which followed, expressed the opinion that it was not an aneurism but an abscess.

In the case reported by Dr. Duke in the *Dublin Med. Press*, 1848, which involved the internal carotid artery, the symptoms and course had led him to believe that he had a case of cynanche tonsillaris to deal with, with the formation of pus, which he was about to evacuate when the fortunate introduction of his finger revealed to him aneurismal pulsation far stronger than could be supposed to be communicated to an abscess by proximity to an artery. A brother practitioner who saw the case with him did not consider the condition so serious, and having kindly, as Dr. Duke most charitably expressed it, made an early call the next morning and finding the patient suffering greatly, undertook to relieve him by puncturing the abscess. This was followed by a violent jet of arterial blood, making it necessary to tie the common carotid. The patient subsequently died from secondary hemorrhage. The danger of falling into such an error in considering deep swellings about the neck should never be lost sight of by the surgeon. It might be said that the history of the case should preclude such an error, since an acute abscess about the tonsil, for instance, would be accompanied by heat, pain, rapid swelling, and febrile symptoms. Yet these were just the symptoms which presented themselves in Dr.

Duke's case, and led him to believe that he had an abscess to deal with, and did so far convince his *confrère* as to induce him to puncture it.

In Mr. Syme's case, which he was called to see in connection with two other practitioners, the diagnosis was between abscess and aneurism. The swelling in the throat "was not circumscribed in appearance, presenting, indeed, the diffused aspect of a purulent collection." But it fluctuated throughout its whole extent, and a strong, uniformly distending pulsation could be perceived over every part of the tumor accessible to the touch. He decided it to be aneurism of the internal carotid, and ligated the common carotid, but the patient died in about thirty-six hours from causes apparently not connected with the operation. The autopsy verified the diagnosis.

Prof. Agnew says upon this point:

"Such a pharyngeal protrusion might be mistaken for an enlarged suppurating tonsil and be punctured with a bistoury; though the symptoms of pulsation, which can be both felt and seen in aneurism, would render an error of this kind as inexcusable as it would be disastrous."

Yet in at least three of the six or seven cases upon record, the mouth could not be opened sufficiently either to feel or see the pulsation.

In Perier's case[1] there were rapid swelling in the throat, great pain, high fever, inability to open the mouth, and altogether a condition so perplexing that Perier and his *confrères* were unable to decide the true character of the case. It was treated by repeated venesection and hot fomentations. At the end of *nine* days hemorrhage from the throat occurred and was repeated. On the fourteenth day M. Récamier was called in, and while attempting to introduce the finger into the mouth, which was done with great difficulty, a profuse hemorrhage occurred and the patient soon succumbed.

In Neuffer's case, a boy, thirteen years of age, was taken with symptoms of inflammation of throat and a diagnosis of angina

[1] Receuil de Memoires de Méd. et de Chirurgie, 1854, tome ii.

tonsillaris was made, and the case treated as such. There were fever, pain, swelling in the throat, noise and throbbing in the head, and inability to open the mouth beyond three or four lines. On the twelfth day hemorrhage occurred and two pounds of blood were lost. On the next day the hemorrhage recurred, and three pounds of blood were lost, followed by the death of the patient.

The autopsy showed an aneurismal dilatation of the internal carotid artery as large as a walnut, with an opening leading into the pharynx.

In Pircher's case, a girl, eight years of age, the symptoms were, if possible, still more obscure and misleading, and pointed strongly to the formation of acute abscess. Indeed, a puncture was made over the external swelling where obscure fluctuation was thought to be felt, but the vessel was not reached. Even after hemorrhage had taken place from the throat, about the eighth day, Pircher, and two colleagues whom he had called in consultation, still regarded it as a deep abscess. Hemorrhage recurred upon the twenty-sixth day, and the patient died. The post-mortem revealed an aneurism of the internal carotid as large as a walnut.[1]

It must be conceded that in such rapidly developing cases, in young persons in whom we should hardly expect to meet with spontaneous aneurism accompanied by such marked inflammatory symptoms, the general practitioner might well be at fault in his diagnosis without meriting harsh censure, while the skilful and experienced surgeon, with no *personal* experience in such cases, could well take warning from the lesson these cases teach.

It would certainly be impossible to make the diagnosis, in such a case as that of Neuffer, or Perier, or Pircher, unless the fauces could be reached and the existence of pulsation determined by the touch. When in a given case of aneurismal tumor in the upper carotid region it becomes a question as to what particular artery is involved, the differential diagnosis would be

[1] Wiener med. Wochenschrift, 1863, p. 553.

between the common carotid at its bifurcation, the external carotid, the vertebral artery, and the internal carotid.

Aneurism of the common carotid at its bifurcation is the usual situation when in the upper portion of that vessel, and its comparatively superficial position and spontaneous origin would practically determine the diagnosis. Besides which, it would not project into the pharynx as would aneurism of the internal carotid.

Aneurisms of the external carotid and its branches, as well as of the vertebral, are, with rare exceptions, traumatic.[1]

The situation and direction of the wound would serve to aid the diagnosis, while the fact that all these vessels lie superficial to the styloid group of muscles, and the dense fascia of that region, would lead to their development in the direction of least resistance—outward; nor would the tumor be likely to project into the throat, as in aneurism of the internal carotid. Conversely, it may be said that aneurism of the internal carotid lying, as it would, below these muscles would not project outward to a marked degree. Agnew says upon this point:

"The deep situation of the artery, covered as it is externally by the stylo-hyoid, stylo-pharyngeus, and stylo-glossus muscles, and by dense aponeurotic structures which extend down to the styloid process, prevents any very marked prominence of such a tumor on the surface of the neck, and as the artery is separated from the pharynx only by the mucous membrane and the constrictor muscle its extension inward becomes an anatomical necessity. Indeed, in this peculiarity lies the chief difference between aneurism of the internal carotid and aneurism situated at the division of the common trunk."[2]

In Duke's case this was the fact. The tumor presented no swelling externally whatever. Nor was there in Mr. Syme's case, and doubtless it is true in general. But in the case I now report it was not the fact. On the contrary there was a striking projection externally, with marked pulsation and bruit. Aneurism of the vertebra is to be distinguished by the fact that only

[1] Agnew reports a case of spontaneous aneurism of the occipital.

[2] Surgery, vol. i. page 591.

by pressure upon the vessel below the tubercle of the sixth cervical vertebra will the pulsation of the sac be controlled. Holmes, however, states that the vertebral is often compressed at a point higher than the sixth tubercle, even in the normal relations of the vertebræ. However, its more superficial position, and the absence of projection into the pharynx, would exclude the internal carotid. In case of aneurism of the internal maxillary or middle meningeal in its extra-cranial portion it might be extremely difficult, and perhaps impossible to make a differential diagnosis, except by a tentative ligation of the external carotid. This question presented itself in my case, as the bullet might well have wounded either of these arteries in its course. But there came to my aid the symptoms of injury of the glossopharyngeal and possibly of the pneumogastric nerves, and nowhere is there such juxtaposition of artery and nerve as to permit of the wounding of both as at or near the carotid foramen. In spite, therefore, of the great projection outwardly, I still felt that there was sufficient ground for a positive diagnosis of aneurism of the internal carotid.

In Bowker's case of aneurism, probably of the internal maxillary or extracranial portion of the middle meningeal, the tumor projected as a soft and obscurely pulsating swelling about three-quarters of an inch from the ear, and closely below the zygoma. There was also a swelling in the mouth, in the angle between the last molar tooth and the cheek, and also about the inner side of the soft palate, above and below the left tonsil.[1]

Having reached this conclusion, it remained to decide upon the method of treatment. Of the various measures suggested and practised for the relief of aneurism injections, introduction of foreign bodies, galvanopunctures, compression and ligature of the artery, only the latter two seem worth considering. All others were absolutely contraindicated in this case. The brilliant results which have been achieved by compression—for the introduction of which we are so much indebted to Irish surgery—the perfect safety of the measure, and the dangers connected

[1] Lancet, 1873.

with all others, would strongly urge the expediency of giving this method a trial in all suitable cases. But it has been pointed out by Mr. Timothy Holmes that compression fails in traumatic aneurism more frequently than in spontaneous, and that we consequently have less to expect from that method in such cases. Compression, too, is difficult to apply in the neck. For its successful accomplishment, moreover, it requires a relay of reliable assistants, perfect control of the patient, a confidence that, if compression fails, the patient will have the courage and resolution to submit later to ligation, a tumor of slow development, and an assurance that nothing will be lost by the delay.

None of these conditions were to be relied upon in this instance. The patient was an ignorant colored woman of irritable nervous temperament, weakened by suffering and inability or indisposition to take sufficient food, who probably would have been so discouraged by failure of compression that she would have refused to submit to further operative procedure. Then the threatening aspect of the case suggested the possibility of early rupture of the sac. Ligature of the common carotid was, therefore, resorted to with the result stated—a failure to arrest the circulation and effect coagulation.

Would ligature of the external carotid or its branches have checked the return current and determined the so much desired coagulum in the sac? Possibly. But with the altered anatomical relations, it would have been somewhat difficult to accomplish this. Besides, I regarded the intracranial portion of the carotid as the principal source of the return flow.

It must be borne in mind that aneurism in this locality differs materially from aneurism in arteries of the extremities in that the conditions more nearly simulate those after ligation upon the distal side of the sac; so complete is the anastomosis of the arteries of the brain that it cannot be said there is developed simply a collateral circulation in cases of ligature of the common carotid, but there is established a continuous flow back into the sac, and, if the external carotid be not ligated, a continuous current through it. In a case of Mr. Guthrie's (*Wounds of Arteries*), after he had ligated the common carotid upon the

cardiac side for wound of that vessel, the hemorrhage from the retrograde current alone was nearly as great as before the application of the ligature. In this respect we have one of the conditions which determine failure of the operation in other situations, viz., so free an anastomosis or collateral circulation as to maintain practically the *status quo ante.*

In a study of the effects of ligature of the common carotid, Dr. Norman Chevers points out the fact that

"In very many of the patients who did not die of brain disease, cerebral symptoms of a very decided kind occurred, such as drowsiness, dizziness, delirium, paralysis of the corresponding side of the face, severe pain in the head, alarming faintness, vertigo, etc.," and that, in fact, "In most of the cases some one or more of the symptoms has presented itself."[1]

Dr. Chevers has further found that death has resulted indirectly in quite a number of cases from the ligature of the common carotid. Doubtless in this, as in many other operations, fatal cases have occurred which have never been reported, while successful ones rarely fail to get into print.

Sir Wm. Ferguson, however, thought that the cerebral disturbance which might naturally be looked forward to, is, in fact, very seldom noticed.[2] In the case I report no cerebral symptoms were observed until the nineteenth day, when convulsions occurred, due rather, I suspect, to the thrombus of the sinuses than to the diminished blood supply to the brain. In conclusion, I desire to express my great obligation to the gentlemen connected with the library of the Surgeon General's Office for their great courtesy and kindness in aiding me to hunt up the references to foreign journals found in this paper.

Since reading my paper, through the kindness of Dr. N. Senn, my attention has been called to the report of a case of traumatic aneurism of the right internal carotid, reported by Drs. Fenger and Lee, of Chicago.[3] It is as follows:

[1] Amer. Journ. Med. Sciences, April, 1846, from London Med. Gazette, October, 1845.

[2] Lancet, 1851.

[3] Gaillard's Med. Journal, July, 1882

A man aged twenty-eight, was shot September 30, 1879, the ball entering the cheek in the right infraorbital region. No hemorrhage. At the end of a week the swelling in the face had entirely subsided, but tumefaction of the right side of the neck remained. On the eighth day the patient was out. On the fifteenth day he called at Dr. Lee's office and complained of inability to speak or swallow, and also of severe pain in the right side of the neck, which he said he could not bend. His appearance was that of a man suffering from severe tonsillitis. With considerable difficulty Dr. Lee succeeded in opening the patient's mouth enough to permit of limited inspection. The tonsils and soft palate were so swollen as to preclude inspection of the pharynx. On the hard palate there was a small, firm tumor, about the size of a hickory-nut. Thinking this might be the ball, surrounded by inflammatory products, he made an exploratory incision with a gum lancet. Upon the removal of some clots of blood, there was a gush of arterial blood, with a peculiar hissing noise, the significance of which the surgeon promptly recognizes.

In consequence of the struggles of the patient Dr. Lee was unable to control the hemorrhage, and death ensued in a few minutes.

I have quoted this case somewhat fully because it emphasizes the danger I have endeavored to point out, of mistaking these cases for abscess.

At a meeting of the St. Louis Medical Society, May 29, 1884, Dr. Hulbert presented the post-mortem specimen of an aneurism of the right internal carotid, which followed upon an attack of scarlet fever. The swelling was punctured upon the supposition that an abscess had formed. Shortly after, there was a profuse hemorrhage. This was checked, and subsequently aspiration was resorted to to discover the character of tumor, blood only flowing through the needle. Dr. H. H. Mudd was then called to see the case and an operation was attempted, but the patient died upon the table, from rupture of sac and hemorrhage into the throat suffocating the patient.

DISCUSSION.

Dr. J. Ford Thompson, of Washington.

I was informed that the discussion on this paper would take place this afternoon, and I arrived just now, when the reading was nearly finished. When one is asked to discuss a special subject in which he has had no experience, it becomes a mere matter of searching the record as to any point that may be suggested by the paper. I have never seen a case of traumatic aneurism of the internal carotid artery. Judging from the few cases on record, I fancy that it falls to the lot of very few surgeons to see such a case. The diagnosis in the case of Dr. Prewitt seems to have been perfectly clear, and he has given the anatomical reasons which justified him in making an almost absolute diagnosis of the condition. I think that, as a rule, there would not be a great amount of difficulty in making the diagnosis of aneurism, although the diagnosis of the source of hemorrhage in a recent case might be attended with a great deal of difficulty. I think that the peculiarity of the bulging of the enlargement into the pharynx is almost characteristic of disease of this artery. As regards the diagnosis, I have here a very interesting case reported by a French surgeon. The aneurism was the result of a fall from a horse and occurred soon after the injury. There was bulging in the fauces, and in the course of a few weeks there was repeated hemorrhage from it. The case was seen by Récamier, and during his examination the hemorrhage recurred and the patient died, apparently without any surgical interference being attempted. At the post-mortem examination it was discovered, as had been supposed, that the disease affected the internal carotid artery. We have a similar case reported by Neuffer, in 1851. In this case a blow on the left side of the head was rapidly followed by bulging both external and internal. This patient died of internal hemorrhage without any surgical interference. The post-mortem showed an aneurism of the internal carotid artery. Speaking of the rarity of extracranial aneurism of this artery, it may be mentioned that quite a number of cases of intracranial aneurism of the internal carotid artery have been reported, but it is not necessary to refer to these.

Then we have the case of Dr. Briggs, in which the diagnosis was perfectly clear. The case of Dr. Briggs is exceedingly interesting, and I think is unlike any other case. The only one approaching it is that of Syme, but that really was not an aneurism of the internal carotid

artery. I refer to the surgical procedure. Dr. Briggs deserves great credit, but the credit of first performing the operation belongs to Syme. I do not think that any man had done the operation previous to Syme in 1856. It is reported in his clinical surgery. The diagnosis was perfectly clear. The case occurred in a distant part of Scotland. Syme was written to by the family physician, and the patient was sent to the hospital and the operation proceeded with. He had thought it all out and considered all the difficulties that might possibly arise. The aneurism involved the internal carotid artery and the operation was the same as that described by Dr. Briggs—Syme's operation probably suggested it to him. After exposing the sac, he made a small puncture, introduced his finger, and felt about for the opening of the vessel. Having detected what he thought was the orifice, he tested it by pressure and found that the pulsation was stopped. Being certain of this point, he cut into the sac above and below, turned out the clots, and completely cleaned the sac. He then had a shining, glistening membrane with no appearance of vessel above or below. He felt for the pulsation and also got a view of the opening into the artery, which was a long slit, and this prevented him from doing as he had contemplated—*i. e.*, catching it with forceps. He then cut directly across the sterno-cleido-mastoideus muscle in order to have more room, and made a dissection first above and threw a ligature around the vessel, and followed out the same procedure below. This patient got well without accident and lost a comparatively small amount of blood during the operation. I consider that one of the most brilliant surgical feats of any time. I think that Syme considered this the crowning surgical operation of his life.

The case of Dr. Prewitt may be open to some criticism, from the fact that his patient was subjected to a very severe and dangerous operation, and yet nothing was accomplished so far as the relief of the patient was concerned. This case also assists in proving the uselessness of ligation of the common carotid for the cure of aneurism of the internal carotid artery. I think that he would have done better by following the operation of Syme or Briggs, or even, if necessary, he might have performed the operation suggested by Guthrie—that is, to make a section of the ramus of the jaw, and pull both sections of the bone out of the way in order to obtain room for further dissection. At any rate, as this condition is followed by certain death without a radical operation, my opinion is that it is the duty of the surgeon, even at the risk of performing so serious an operation, to do the old opera-

tion, cut into the sac and ligate both ends of it. A number of cases of aneurism of the internal carotid within the cranium, the ophthalmic aneurism, or aneurisms by anastomosis, as they were called, have been cured by ligation of the common carotid; yet so far as we have gone, the fact stands out that it is useless to attempt to cure a developed aneurism of the internal carotid by ligation of the common carotid. One reason of this difference is this tendency to bulge inward. This want of support to the sac is a most unfavorable condition to the deposit of plastic material by which the diseased artery is strengthened temporarily to enable it to resist the constant pressure, and also the intercommunication is so great that the circulation instead of being retarded goes on as readily as before. In one of the cases examined quite often by the surgeon, the blood could be seen beneath the mucous membrane of the throat.

Suppose a man should find a condition like this with the bulging in the throat and bleeding, what can be done? I know nothing more embarrassing, and requiring more judgment and determination, than to treat a case like this. It would be difficult to control the vessel through the mouth. I should resort to ligation of the common carotid artery. It would be difficult to find the bleeding vessel without the guide of an external protrusion. If we find an enlargement presenting internally and very little externally, it is a more serious question and requires more courage to undertake its treatment than where we have a large pulsating sac externally. In such a case, we should all probably ligate the common carotid artery. It is a question, in some of these cases, whether it would not be better to let the case alone.

The fact that pulsation does not cease after the operation is no proof that a cure may not follow. When the blood supply or the strength of the arterial current is diminished, it predisposes to the deposition of plastic material. By ligating the common carotid, the flow of blood is diminished, and although pulsation may not be prevented, the blood supply is in great measure cut off, and in other localities this would have a tendency to cure. In traumatic aneurisms of other parts of the body, I have operated a number of times, but this is exceedingly easy where the circulation can be commanded. The old operation is the one to be performed. I think that the sac should be opened in all cases of traumatic aneurism where it is possible to do so.

In this particular affection I have had no experience, and I am only speaking upon the general principles of surgery, which I think would govern me in the treatment of such a case.

Dr. William T. Briggs, of Nashville, Tennessee.

A case into which I was very innocently drawn has been referred to by the essayist. The patient was brought into my clinic-room without previous examination. The diagnosis of traumatic aneurism was made without naming the special artery which had been wounded. The case was as follows:

Thos. B., aged twenty-three, was admitted into the College Hospital on account of a tumor in the left parotidean region. The tumor was of considerable size, circumscribed and smooth on its surface, with a strong, expansile pulsation when the hand was pressed on it. The swelling was lessened by pressure on the common carotid, and a loud bruit was heard when the ear was applied. The swelling encroached on the throat, causing difficulty of swallowing; upon this anterior part of the swelling there was a red and slightly raised cicatrix a half inch in width.

The history obtained from the hospital record was that six weeks previously he had received a stab at the point now marked by the cicatrix, which had bled furiously at first but was checked by the pressure of the hand. His wound was dressed by a compress and bandage. A few days afterward hemorrhage again occurred, but was easily arrested. Several subsequent hemorrhages took place. A month after the injury had been inflicted the wound had entirely healed. Soon afterward the formation of an aneurismal tumor was recognized and he was sent to the hospital for surgical treatment.

I proceeded to do the operation on the general principle that a traumatic aneurism is simply a wounded artery and should be treated as such.

The patient having been placed on his back with his head turned to the opposite side, the knife was pushed into the most prominent part of the tumor and its withdrawal followed by my finger so as to prevent loss of blood. I tried to find the wound in the artery and thought I had done so.

Keeping the pressure steadily on the vessel which I thought was the wounded one, I enlarged the opening upward and downward to the extent of several inches. At once large black clots were discharged, followed by a gush of arterial blood, which was arrested by stuffing the wound with compressed sponge. Without much thought, I enlarged the incision downward and ligated the common carotid artery at the point of election. On the removal of the compressed sponge the

hemorrhage was as violent as before. I placed my finger into the cavity of the sac and at once arrested it. My assistant then compressed the opposite common carotid artery, but the effusion of blood when the pressure of my finger was relaxed again returned. I then recognized the fact that nothing but a ligature on each side of the wounded artery would arrest the hemorrhage. Having the immense wound held agape with curved spatulæ, my left index finger was kept on the opening in the wounded artery while the tissues were divided by scratching through them with a blunt knife held in the right hand; the artery needle, armed with a silk ligature, was then guided by the finger that rested on the artery, passed around it, and was so far drawn out as to show that nothing was taken up with it, when the needle was withdrawn and the ligature tied on the distal side of the opening. Another ligature was placed on the proximal side. A few small vessels having been tied and the clots of blood sponged out, it could now be seen what had been done. The incision from one extremity to the other measured eight inches, and yet there was not room enough. I thought seriously of sawing through the jaw bone just anterior to its angle and turning it aside, but I concluded to attempt to place a ligature first without further mutilation, and I succeeded. The whole interior of the cavity which had formed the aneurism was lined by a smooth, shining membrane, and all the intricate anatomical parts pressed out of the way. In the bottom of the wound the styloid process could be seen and felt, while just anterior and internal to it the ligatures were seen coming from the internal carotid artery. Being satisfied that all was now safe, the wound was closed. The patient fully recovered and is still living. I was led to do this operation from the example set by Syme, but more especially by the principles taught by Guthrie, that nothing save a ligation on each side of a wound in an artery will permanently arrest hemorrhage from that artery. The principle is well illustrated in this case.

Dr. D. Hayes Agnew, of Philadelphia.

About three years ago a lady from New Jersey came to the University Hospital and engaged a private room. She had a tumor as large as an orange just beneath and behind the angle of the jaw, and another projecting into the pharynx. This tumor had grown slowly for about eight months. She attributed it to a blow on the side of the head. When I came to examine it, I found, by making pressure on the primitive carotid, that the tumor diminished materially in size. It

had a distinct pulsation and a distinct bruit. I considered it a case of aneurism of the internal carotid artery. I tied the primitive carotid above the omohyoid and most of the pulsation ceased, but some could still be discovered. I supposed that this was due to communication with the external carotid artery. I then prolonged the incision and tied the superior thyroid. This diminished the pulsation. I went a little higher and tied the next vessel, the lingual. The pulsation then disappeared entirely.

The patient did well for two weeks, when pulsation in the tumor returned. I found, by making pressure on the carotid artery of the other side, that all motion ceased. I then placed a ligature on the opposite side. No sound or motion could then be detected—the tumor became quite solid. I was obliged to leave the city, and during my absence ulceration into the pharynx occurred and a large gush of blood followed. The resident stuffed the cavity, but the woman died eight days later, apparently from septic poisoning.

Although this was a spontaneous aneurism, it has a bearing upon some of the points presented to-day. I had in this case determined what should be done if rupture occurred. If I had had the opportunity, I should have made a section of it and tied above and below the sac. From the history of the cases which have been recorded, I believe that instead of temporizing by tying the artery below, the operation should be a formal one of making a section of the jaw and ligating above and below the sac.

Dr. A. VANDERVEER, of Albany, New York.

Dr. Agnew's remarks are, I think, in the right direction. In December, 1882, a patient, forty years of age, was sent to me. He was a farmer by occupation and had labored hard. While harvesting, his work compelled him to turn his head very much to the right side, and he thought that he in this way did himself harm. In December, a swelling was noticed which was decided to be due to aneurism of the internal carotid artery. He came to the Albany Hospital and I watched him carefully for several days, and went over the ground pretty much as Dr. Prewitt has done, looking up the authorities.

One morning he asked me to try compression. Assisted by three or four intelligent students, I tried compression faithfully. At this time the patient presented the following condition: there was a tumor occupying the left side of the pharynx and projecting as an enlarged

tonsil would do to the median line. The pulsation was very distinct. With the stethoscope, a bruit could be plainly heard. Compression of the common carotid diminished it materially and lessened the pulsation, but did not stop it. Compression of the common carotid artery continued for six days caused marked diminution, and the patient said that he felt much relief. The tumor in the pharynx at the end of this time seemed to be harder. During the treatment the man was kept partially under the influence of anodynes. He was a firm, brave man and bore the operation well. He now wished to return to his home, and did so. In February he again came to the hospital. The tumor was then as large as before compression had been practised. It pulsated quite distinctly, and the wall seemed a little thinner. Compression was again resorted to, and followed out continuously night and day, resulting in a marked diminution in the size of the tumor. When compression was discontinued the tumor did not enlarge. He remained in the hospital for a week or ten days longer, during which time the tumor did not increase in size, and I felt very much encouraged. He went home and for four or five weeks was apparently in good health. One day he suddenly complained of terrible pain in the head, and fell down, dying a few minutes afterward. The family physician made an autopsy, but failed to find any rupture of a bloodvessel, and he was at a loss to give a correct report as to the cause of death. The specimen was kept, and last fall he kindly gave it to me. I examined it and found dilatation of the internal carotid artery, which was as large as my little finger. Its walls were much thickened. As to the cause of death, I am not quite clear. I report it as a case in which compression was faithfully tried.

Dr. L. McLane Tiffany, of Baltimore.

In the cases reported there has been a most marked difference which has not been referred to. In one case the wound was at such a distance from the base of the skull that it could be treated according to the general principles of surgery. The vessel was cut down on and ligated above and below, and the patient recovered. In the other case the wound was so close to the base of the skull that a distal ligature could not be applied. The surgeon was then brought face to face with a large artery tied on the proximal side and with no room to apply a ligature on the distal side of the wound. In Guthrie's *Commentaries* we have reported the case of Dr. Twitchell, which occurred in 1805, in New Hampshire. In this case a large portion of the neck was blown

away by the discharge from a cannon. The internal carotid artery was exposed. Eight or ten days after the occurrence of the accident, while Dr. Twitchell was in the house, the vessel gave way. He put his finger on the bleeding point, and with the assistance of the patient's mother, ligated the vessel below the opening. When he removed his finger the hemorrhage was as great as before. There was no room between the opening in the vessel and the base of the skull to apply a ligature. He, therefore, applied a graduated compress, pressing the artery against the base of the skull. This patient recovered. This was attempted in the case reported. The only possible improvement on the operation that I could suggest is that the aneurism should have been laid open at first and pressure above made at the time when the carotid was ligated below. I venture to think also that in these cases, which are extremely rare, the proper treatment would be to make temporary compression beneath the wound by means of the finger or an artery compressor and immediately afterward treat the wounded vessel as may be best. If a ligature can be applied above and below, all right; if not, tie below and make compression above. Possibly it might be wise to divide the vessel between the two. In regard to the division of the jaw, that can only be decided when we come to consider the particular case. It was not done in the successful case.

I was once so fortunate and unfortunate as to see a slough of the internal jugular vein at the base of the skull treated in the way spoken of. Here it was not necessary to divide the ramus of the jaw. The wound was found, a compress put upon it, and hemorrhage prevented by making pressure against the base of the skull at the jugular foramen. The case was that of a child, three or four years old, with scarlet fever. Abscess of the neck occurred, and three weeks later the neck swelled enormously on one side and it was evident that a vessel had been opened. The swelling extended from the ear almost to the clavicle. The child was very anæmic. It was decided to open the cavity and tie the vessel. The child having been rolled in a sheet, was held by the nurse. Dr. Smith, Fellow of this Association, and I, arranged the method of operating before beginning. He was to stand behind the child and lay the swelling open from the lobe of the ear almost to the clavicle, then drop the knife and hold the incision open with his fingers on either side. I was to sweep out the clot with one hand and to put one finger of the other hand on the wound in the vessel. The operation was done exactly as laid down in the programme.

Scarcely any blood was lost. The hemorrhage once controlled, there was not much further difficulty. I venture to think that in those cases where the carotid artery is injured or where there is an aneurism too high to permit of the application of a distal ligature, that the proper treatment would be to apply a proximal ligature, lay open the sac, and make compression against the base of the skull.

Dr. Briggs. In the case referred to, the operation in the internal carotid artery was very close to the beginning of the carotid canal—it was not more than half an inch from it. But, after all, the operation was not so very difficult. The continuous hemorrhage was the only trouble. As before remarked, the cavity of the adventitious sac was lined with a smooth shining membrane which protected the anatomical parts around. The operation performed was quite different from the ligation of the artery when not the subject of traumatic aneurism.

Dr. Prewitt. I am gratified that the report of this case has brought out so much discussion and has elicited so much information. I wish to say with reference to Dr. Thompson's remarks, that, if I have read the reports aright, the cases of Perier and Neuffer were never believed to be aneurisms. They were treated as abscesses. In Neuffer's case, even after hemorrhage had occurred more than once, he and his colleagues believed that it was not an aneurism. In Perier's case it was not supposed to be an aneurism. The mouth of the patient, a boy of thirteen, could not be opened, and at the time Récamier was called in, the throat had not been seen. It was while he was attempting to press open the jaw that a sudden gush of blood occurred and determined the fatal result. I do not know where Dr. Thompson got his references, but that is the way I read the cases from the original sources.

I agree with all who have insisted that the old operation is the proper one in traumatic aneurism, where it is possible to accomplish it. I believe that there is no question about that. If any Fellow of the Association will look at this specimen, I think he will admit that, as Dr. Tiffany has said, it was not possible to put a ligature on the distal side. There is no artery on the distal side of the opening.

Dr. Thompson says that these cases prove the uselessness of ligature of the common carotid in the treatment of aneurism of the internal carotid. I will say that of all these cases of aneurism of the internal carotid, there are but two where ligature has been applied. Syme's case proved fatal, not from the operation, but from vomiting and purging which seemed to have no connection with the operation.

In Bowker's case, the aneurism probably involved the internal maxillary or the external portion of the middle meningeal. Bleeding occurred, and he tied the common carotid artery; the patient recovered.

Professor Agnew states that in aneurism of the internal carotid artery he believes that the formal operation of sawing through the jaw, turning it out, and ligature of the vessels on both sides of the aneurism should be resorted to. That is all well enough, and I am glad to hear him make the suggestion, but in this case the aneurismal sac was closely adherent to the jaw bone. It was absolutely a part of the base of the skull. When I had my finger in the sac, I could feel some of the bony prominences, and they felt as though they were naked. As to sawing through the jaw, in the first place, it would have required nice dissection to have gotten the sac loose; and, in the second place, after this had been done, there would have been no artery above which could have been ligated. It would not even have been possible to tie the sac itself. It was practically obliterated in its upper end through its close connection to the base of the skull.

Dr. Vanderveer has alluded to compression. We should not expect that to succeed where ligation of the common carotid has failed. The greater comprises the less. If absolute control of the circulation will not effect a cure, we should not expect compression to do so. It is true that compression is sometimes successful after being persisted in for a great length of time. Ligature might have succeeded in this case, if it could have been left alone for a sufficient length of time. It was apprehension of rupture which induced me to do this operation. With such appearances, compression would have been out of the question. Under other circumstances, I should have tried compression faithfully. When I found from my dissection that it was so closely adherent to the bone that there was no possibility of getting behind the sac, I abandoned all idea of Syme's operation.

Dr. Tiffany thinks that it would have been better to make compression at the distal side. Possibly. Yet under the circumstances, believing, as I did, that we had no artery distal to the sac, it seems to me that it would have been bold surgery to lay open the sac and attempt to find the opening. I tried it when I was compelled to do so, and yet I was unable to satisfy myself that I could control the hemorrhage while I was laying open the sac. I think that it would have been a bold procedure to cut down into the sac in this case. I might have stopped the bleeding. I think that part of the fatal result

was due to the blocking up of the internal jugular and the complete thrombus of the vessels on the inner side of the skull. The inferior petrosal and lateral sinuses were blocked with thrombi beyond the torcular Herophili. I think that the epileptiform convulsions which occurred were due to this condition. I must say that I think death was largely due to septic conditions. I am aware that the disciples of Lister will say that this should not have occurred. I will not dispute this, but it did occur. I am aware that the course pursued is open to criticism, but that comes in the experience of every surgeon when he meets with cases which he is not accustomed to treat.

SUCCESSFUL NEPHRECTOMY ON A PATIENT OF TWENTY-THREE MONTHS.

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R. B., born Oct. 4, 1883, of healthy parents, appeared at birth and during his earliest months perfectly well. During the ensuing winter his nurse noticed an enlargement on the right side of the child's abdomen. Later, the attention of the family attendant, Dr. M. B. Folwell, of Buffalo, was called to the fact. It steadily increased without corresponding impairment of health, and in spite of treatment. In June, 1885, Drs. E. M. Moore and Whitbeck, of Rochester, were consulted. The general conclusion arrived at was a lesion of the right kidney. At this time the urine was alkaline.

July 31, 1885, I first saw the child, it being then in apparent good health. The urine was alkaline from volatile alkali. It was stated that there was occasional dysuria. Under the microscope were found only numerous crystals of triple phosphates. There was a history of steady enlargement of the growth. Dr. Folwell giving an anæsthetic, I first examined the external genitals; finding adherent prepuce, I released the adhesions with a probe. I next carefully sounded the bladder, but could find no calculus. On examining the abdomen I found a firm, resistant tumor, about the size and shape of a fœtal head at term, occupying the right half of the abdominal cavity. It seemed unquestionably an enlarged kidney. Introducing an aspirator needle I drew off fifteen cubic centimetres of a brownish liquid which was odorless, this amount being all that would flow from the puncture. This I submitted to my colleague, Prof. Witthaus, for examination, withholding all information—even as to sex of the patient—save that it came from an abdominal tumor. He kindly furnished me the following report:

"I find that the liquid which you left me for examination does not contain uric acid, nor any very readily detectable amount of urea; on the other hand, it contains paralbumen in considerable quantity, and a peculiar modification of hæmatin which is stated by MacMunn to be peculiar to ovarian and parovarian cysts. From all characters of the liquid I should say that it came from a cyst which does not communicate with the pelvis of the kidney. All the microscopic and chemical characters of the liquid are those of the fluid of an ovarian cyst. There are, however, no cholesterine crystals, which are usually though not always present."

Microscopically I also found cells which could not be distinguished from the Drysdale cells. In endeavoring to reconcile these chemical and clinical facts, I recalled a statement of Esmarch's to the effect that paralbumen has been found in the fluid of renal cysts; also the known fact that the Drysdale cell has been found in various intra-abdominal cysts. My diagnosis was fibro-cystic degeneration of the right kidney, probably of congenital origin.

Sept. 5. Drs. Folwell, Mann, and myself again anæsthetized and carefully explored. By aspiration we got again a small quantity of fluid similar to that first obtained. In the five weeks intervening since previous aspiration the tumor had notably enlarged and become less movable; while the general health of the little patient seemed deteriorating. The tumor was now so protuberant that he was actually wearing an abdominal suspensory, slung from the shoulders, in which he supported most of its weight.

Operation was proposed and consented to. The patient was removed to the Gates Laparotomy Pavilion in connection with the Buffalo General Hospital, to which, indeed, he was the first patient admitted. He had thus the advantage of new and clean apartments.

Operation Sept. 15, 1855. Present: Drs. Rochester, Mann, Phelps, Hopkins, and Folwell, who gave the anæsthetic, and the house physician and trained nurses. Chloroform (with amyl nitrite one per cent.) was given till the operation was half completed, when ether was substituted. No spray was used, but strict antiseptic details were observed in every other respect. Incision in right linea semilunaris, its middle opposite the umbilicus. On opening the peritoneum the first object to meet the eye was the appendix vermiformis, which lay stretched out over the surface of the tumor, almost at right angles to the line of incision, so far had it been crowded away from its proper locality. The tumor was, of course, retroperitoneal, but occupied the entire right half of the abdomen; the cæcum and ascending colon were just to the

left of the middle line. Exploration with the finger and sound revealed only the most trifling adhesions in the peritoneal cavity. A small trocar passed into the interior of the tumor failed to remove more than a spoonful of fluid. The abdominal incision was then extended till it was thirteen centimetres long, and the peritoneum covering the growth incised. With but little difficulty this was separated all around it till the tumor shelled out from its serous covering, and lay loose save for its pedicle. Two large veins being quite conspicuous in the pedicle, they were first tied separately with catgut, then the whole was tightly seized with a pile clamp, tied in halves with stout silk, the tumor cut off and its base seared with the thermocautery. For the sake of safety, the whole was then once more enclosed in a catgut ligature, after which it was dropped.

Except that which was contained in the tumor, not more than fifteen cubic centimetres of blood was lost during the entire operation. After a careful toilet the abdomen was closed by numerous silk sutures. The entire procedure, including dressing, lasted forty-five minutes. Shock was comparatively slight.

Convalescence was marked by only one incident worth notice. The second evening his temperature began to rise: at 6 P. M. it was 103°, at 10 P. M. 104°, at 11 P. M. 104.7°, at 4 A. M. nearly 106°, in spite of half-hourly doses of tinct. aconite root. At 4 A. M., when his temperature was so nearly 106°, I ordered three minims of aconite tincture and five minims of tincture of digitalis hypodermatically. In *two hours* his temperature had *fallen more than six degrees*. This was a happy turning of a crisis which seriously menaced his life.

In due time chloroform was given for the removal of the stitches, and on the twelfth day he was removed to his home. At present writing, seven months later, he is the picture of health.

The tumor was, as I had supposed, a fibro-cystic degeneration of the kidney, the cystic element largely predominating. In the neighborhood of the renal pelvis a very thin portion of true kidney structure could still be distinguished. Immediately after removal and before section, it weighed very nearly four pounds, lacking only a fraction of an ounce. The function of this kidney seemed to have been so gradually transferred to the other that at no time after the operation was there the slightest disturbance in excretion or voidance of the urine.

I am aware that at the present date over two hundred and fifty nephrectomies are on record, yet among them all I can find account of but three patients who were of ages near that of mine. These are as follows:

Jessop, of Leeds, operated on a child aged two and one-quarter years, for encephaloid kidney. Lumbar incision. Patient recovered from operation and died nine months later from recidive. (*Lancet*, Am. ed., 1877, p. 480.)

Kocher, of Berne, reported a patient aged two and a half years, operated on for adeno-sarcoma. Abdominal incision. Death on the second day. (*Deutsche Zeitschrift f. Chir.*, ix.)

Czerny operated on an infant of eleven months for adenoma of left kidney. Abdominal incision. Death in sixty hours. (*Deutsche med. Wochenschrift*, 1881, 31.)

It would thus appear that mine was the youngest patient who has ever survived nephrectomy, he being twenty-three months old when operated on. The only other observation I have to make in connection with the case is that the abdominal incision was made not from choice, but from necessity, the tumor being altogether too large for extraction from so small an abdomen in any other way.

LIPOMA TESTIS, OR A LARGE ACCUMULATION OF FAT IN THE TUNICA VAGINALIS.

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LIPOMATA of the spermatic cord are rare enough always to attract attention, but lipomata of the testicle are of such exceeding rarity that, believing I have had a case which deserves this designation, I desire to put it on record and make it the basis for a few comments.

J. K., æt. forty, was referred to me, by Dr. Conrad Diehl, early in September, 1885. Patient had noticed an almost painless, slow but continuous enlargement of the right testicle for the past eighteen months. It was then about the size of a cocoanut, and caused inconvenience only by its weight and bulk.

On examination the scrotum was filled by a large mass which crowded the left testicle into a small space at its upper part. This tumor was solid yet soft, not tender except when the right testicle, which was in its upper part, was pressed upon. On handling it an ill-defined fluctuation was noticed. By exploratory puncture all suspicion of fluid was removed. Patient had every appearance of robust health, and the idea of malignancy could not be entertained. Over the surface of the tumor the scrotal integument moved with perfect freedom. An exact diagnosis was not ventured, though there was strong suspicion that the mass was fatty; but radical operation was advised and consented to.

October 4th the patient went to the Buffalo General Hospital, where I operated, Dr. Diehl and the house staff being present and assisting. By a free incision the tunica vaginalis was exposed; its appearance was not typical of anything save distention from within. A second free incision was made through this and a mass of densely packed fat was revealed. This was very slightly adherent to the interior of the tunic,

and was turned out without difficulty after enlarging the incision. After completely shelling it out I found, on separating the lobular masses with the fingers, the right testicle not merely embedded in its upper part, but incorporated with the fat by apparently intimate tissue connection. It was, moreover, supplied with blood both from the testis and from the cord. The cord seemed to enter the tumor and then pass in its substance for about two inches before reaching the testicle. At a loss to account for so much fat, I carefully explored the external ring for evidence of past or present hernia, but could find none. The ring and canal were no larger than on the other and normal side.

Finding the fibrous trabeculæ and bloodvessels radiating from the testicle out into the fatty mass so numerous and distinct, I decided to remove the whole *en masse*. The balance of the operation then simply resolved itself into a castration which was made in the conventional way. Recovery followed without incident.

The entire mass, after removal, weighed just three pounds. On dissection nothing further could be made out than I have already stated. I was unable to come to any positive conclusion as to the exact point of origin of the adipose mass. While the blood supply from the cord might indicate one origin, the equally evident bloodvessels from the testicle pointed as strongly to another.

In fact, I consider it impossible to say from exactly what part of the spermatic tract this neoplasm originated, and while it would be of pathological interest to know, yet I hold it of small clinical importance in this case, and deem myself clinically correct in speaking of the case as lipoma testis, or, if the term be preferred, *lipoma intra tunicam vaginalem*.

Realizing the rarity of the lesion, I was led to make a careful study of its literature, and distrusting the resources of my own library, I enlisted the aid of Dr. S. S. Adams, of Washington, who devoted a fortnight to a search through the indices and files of the library of the Surgeon-General's Office. As the result of his labor he could find but three cases the titles of which allied them to that which I have reported. As will be seen, not one of these properly belongs here.

In the *Dublin Med. Press*, 1847, xvii. 56, is a paper by J.

A. Orr, entitled "Operation for Lipoma of the Testicle after the Inhalation of Sulphuric Ether Vapor." "J. Dillon, æt. forty-seven, admitted to City of Dublin Hospital, October 17, 1846, for lipoma of right testicle, coming on after an attack of orchitis, the result of a gonorrhœa contracted eighteen months before." Orr goes on to speak of its granular and fungous aspect, and without further use of the term lipoma and without saying anything of the method of operating, the specimen obtained, or even of the result, he devotes the balance of his paper to a consideration of the action of ether. Moreover, this seems to be one of those cases, to which I allude further along, where the terms lipoma and fungus of the testis were indiscriminately used.

J. Morgan published in the *Dublin Med. Press and Circular*, 1867, iv. 546, a "Clinical Lecture on Lipoma Testis." His case is further described as lipoma of the testis in an advanced stage, aggravated by neglect and irregular living. It may be briefly summarized for present needs thus: Right testicle acutely inflamed after injury, inflammation subsiding into chronic state. After seventeen months appeared discoloration of skin, thinning of same, ulceration, and discharge; after this a fungous formation. In the further particulars of the case nothing appears indicating a fatty condition of the parts.

Turning to other sources, and not looking merely for clinical reports, there is scarcely anything to be found. I note, however, that Callisen referred distinctly to lipoma of the testis:

"Si ex superficie albugineæ vel ipsa tunica vaginali excrescentiæ surgunt totum demum testum involventes, et scirrhum seu fungum mentientes, ipsius tamen testes substantia parum aut vix statu naturali aberrante; malum naturam lipomatis sequitur, viz unquam in scirrhum et carcinoma abiens." (*Systema Chirurgiæ Hodiernæ*, 1800, ii. 145.)

Curling, in Todd and Bowman's *Ency. Anat. and Phys.* (article "Testicle, Abnormal Anatomy") says:

Collections of fat in the scrotum have been known from the time of Galen by the term *steatocele*. I suspect they all originate from the spermatic cord. In examining the testicles of a young man who died of pleurisy I found a quantity of fat along the cord and around the epi-

didymis, and some also beneath the tunica vaginalis covering the posterior part of the testicle. When developed in considerable abundance this deposit sometimes forms a tumor in the groin or in the scrotum. A tumor of this kind has been taken for an omental hernia.

Such tumors were known by Pelletan as *hernies graisseuses*.

An interesting case of large fatty tumor in the scrotum originating in the spermatic cord, was seen by several surgeons in 1844, much difficulty having been experienced in making out the nature of the swelling; this case is fully reported in Curling's *Diseases of the Testis*, 4th London edition, 1878, p. 559; and is briefly as follows:

Patient, æt. forty-three years, of spare habit, perceived an enlargement in left side of scrotum which was taken for hernia; reduction was attempted by Lawrence and failed; it was then diagnosticated as irreducible omental hernia. Brodie and Harding failed to make out its exact nature. Tumor continued to increase. After fourteen months Curling found it the size of a large orange, soft and inelastic, connected above to the thickness of the spermatic cord. The testicle was distinct and situated below and to the inside. On rising in the morning it swelled and felt heavy and painful; before evacuation tense and painful, afterward resumed its former state. Curling thought it an adventitious growth in the scrotum. In twelve months it attained the size of a melon with testicle in front. Brodie, Travers, and Lawrence were unable to diagnosticate, but united in recommending its removal. Lawrence, assisted by Travers, operated. It was impossible to save the testicle, so the whole mass was removed. Tumor six by eight inches, partially lobulated, adipose tissue, originating high up in the spermatic cord. Recovery. Four years later Curling removed from the same patient a small lobulated, fatty tumor, size of a chestnut, which had probably escaped removal at the previous operation from the spermatic cord. Ten years after the first operation two other small fatty tumors were removed by Curling. These were situated a little lower.

I give this case rather because it is instructive than because it belongs here, since it makes no pretence to being a case of lipoma testis. Since then, Kimball (of Lowell [?], *Boston Med. and Surg. Journ.*, exact reference unknown to me) and

Jobert (*Gaz. Méd. de Paris*, 1850, p. 558) have reported authentic cases; in the latter the tumor was of somewhat mixed variety. The obscurity of diagnosis is well shown in that Kimball believed his case to have something to do with an old hernia. Deguise also reports (*Ann. de la Soc. de Chir.*, ix.) a case where the tumor was as large as an adult head, had been growing a dozen years, and required an incision of thirty centimetres for its extraction.

Numerous authors state that lipoma of the cord may extend downward and spread over the testicle, and I do not overlook the fact that in my case the fatty growth may have begun in this way, yet when it came under observation there was nothing to indicate such an origin.

According to Follin and Duplay (*Pathol. Externe*, vii. 379), lipomata of the cord are usually stationary and of small size, but in certain cases acquire large dimensions. Developing upward toward the abdomen, they may greatly obscure diagnosis. After they have attained great size they usually grow downward. Thus, Wilms removed a lipoma of the cord of 20 pounds; Gascoyen, one of 5¼ pounds; and Mr. Lane, one of 5½ pounds. In my case, however, the tunica vaginalis was so tensely distended with fat and the cord above it was so natural in size and appearance that I cannot avoid the convictions I have expressed.

Moreover, Delafield and Prudden state that "lipomata, either pure or in combination with myxoma and sarcoma, may arise from the connective tissue of the spermatic cord, *or from the tunica albuginea*" (*Path. Anat. and Hist.*, p. 441). This statement, brief as it is, is the only one bearing on the subject that I have found in any of the works on pathological anatomy.

In looking over various authors of the past century, I have been peculiarly struck by the looseness of their phraseology concerning affections of the testis. Thus, as already remarked, lipoma testis and fungous testicle are almost synonymous terms according to their usage; Brodie, Astley Cooper, Samuel Cooper, and others as well known, are not free from this fault. It is not, perhaps, incredible that a tense distention of the tunica

vaginalis by a mass of fat might lead to atrophy or even ulceration, and to the formation of an adipose hernia, but in each case that I have alluded to above, where the title would imply a lipomatous condition, nothing of the kind was revealed, but rather one of the true fungous lesion.

Therefore, accepting the cases reported by Kimball, Jobert, and Deguise as authentic, they constitute all that I have been able to find, and I may consistently claim that mine is the fourth on record. This rarity of the lesion, coupled with its pathological interest and the obscurity of diagnosis attending such cases, must be my excuse for taking up the time of an association which yet, I believe, is not above a careful study of small things.

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DISCUSSION.

Dr. L. McLane Tiffany, of Baltimore.

There is little to discuss when such successful cases are brought to our notice. The rarity of the second case has been well shown. In regard to the nephrectomy, there can be no doubt as to what is the proper incision in this operation, but in the case reported the abdominal incision was called for by the size of the growth and the judgment of the operator was allowed scarcely any play.

The chief point of interest seems to me to be with reference to the transference of function from one kidney to the other. It is a matter of extreme doubt whether that kidney ever performed any urine-secreting function at all. Fibro-cyst of the kidney in the child, is

almost always congenital, and if in extreme degree is, I think, frequently accompanied by lack of development in other parts of the body. A certain number of cases are on record where the arms, limbs, genitals, or other parts have been malformed. Dr. Park holds the same idea for the child as for the adult, but others disagree with him, and it appears to me that they have the advantage in the discussion of the matter. It seems to me that the Malpighian capsules which become the cysts do not unite with the pelvis of the kidney, and, as a result, urine is not secreted. Urea is, I believe, always found in these cases in children, and the other elements in the fluid appear to be due to degeneration of the retained matters. I take this to be a case of malformation of the kidney which has never performed its function on account of a lack of connection between the Malpighian capsules and the pelvis. The secretion has not been removed, but has remained, gradually distending the capsule until we have a cyst formed. This, to me, is the principal point of interest—as to the etiology of the affection. The success which has crowned the operation, we can, of course, only commend.

Dr. W. H. Carmalt, of New Haven, Connecticut.

It is quite unnecessary for me to say anything after the elaborate paper and the remarks of Dr. Tiffany. When I was notified that I was expected to speak upon this subject I looked up the literature of lipoma of the testis, but could find nothing bearing upon this case. References to lipoma of the cord descending into the scrotum and to lipoma of the scrotal tissues themselves were not infrequent, but to lipoma of the testis there was none. I was, therefore, compelled to wait until I had heard the essay before I could find out what we were dealing with. It is a matter of congratulation that the archives of the Association are to be enriched, through Dr. Park's industry, with another of these very rare cases. It is an interesting point with reference to tumors of the testicle, in general, that they are nearly always mixed tumors, and this seems to be no exception to the rule. They are rarely homogeneous. We do not have pure sarcomas, but fibro sarcomas and cystic sarcomas. This is equally the case in carcinoma. The growth is almost invariably mixed with sarcoma, and thus thereby a twofold danger, both connective tissue and epithelial elements are in a state of active proliferation. We should, I think, therefore, in most cases recommend extirpation of the tumor, even if the diagnosis is not absolutely made out.

In regard to the first case, I have nothing to add to what Dr. Park has said. The abdominal incision was certainly indicated in this case. No general rule can, however, be laid down as has been attempted; in each case, I think the decision between the lumbar and abdominal incisions rests upon the accessibility of the tumor as we find it.

Dr. E. M. Moore, of Rochester, New York.

I saw this case of tumor of the kidney described by Dr. Park, before it came under his charge. He refers to my opinion in a general way, giving the impression that the diagnosis had been made. The child was brought to me by Dr. Folwell. He had not the slightest idea of what the condition was. I pronounced it a fibroid of the kidney, but how far the cystic element prevailed I did not know. I think that true fibroid of the kidney is not very common. In looking up the literature I have been much disappointed. A great deal is said of malignant disease and of sarcoma of the kidney, but fibroid tumor of the kidney is treated in a very indefinite way.

My diagnosis of fibroid tumor of the kidney in this case was the result of a very singular experience that occurred to me many years ago. I had the results of a post-mortem examination brought to me where a tumor of the kidney weighing ten pounds was removed from a boy ten years of age. On making the dissection we did not find the condition described by Dr. Tiffany. We found that the elements of the pelvis were distended and spread out through the whole of the tumor, so that undoubtedly there was secretion in this case.

I had another case in a lady under observation for eighteen years. When I first saw it the tumor was as large as a child's head at term. I was doubtful as to its true character, with the exception that I was confident that it was not malignant. I thought that it was a fibroid, but had a very indefinite notion as to its situation. I assured the patient that but little danger was to be apprehended. She lived for eighteen years after this. The tumor slowly enlarged until it acquired perhaps twice the size it had when I first saw it. The patient suffered with ill-health and had a moderate hemiplegia. She finally died in consequence of suppurative infiltration throughout the whole of this kidney. I made the post-mortem examination and ascertained that it was a true fibroid of the kidney, presenting the same appearances as seen in the first case. I am firmly convinced that in this lady's case, the tumor had existed for forty years and had not impaired her health materially. These three cases have come under my observation and in

two I have seen the post-mortem results. In the third we have the result in Dr. Park's successful operation. I think that many years ago I saw two other cases, but they were not verified.

Dr. Charles T. Parkes, of Chicago.

I understood the speaker to state that, on opening the abdomen, he found a portion of the colon on the surface of the tumor. I would ask whether in the previous examinations there was anything to lead him to suspect that this condition was present? Were there any signs indicating the presence of the bowel over the tumor?

Dr. Park. In reply to the inquiry of Dr. Parkes, I would say that the appendix vermiformis, the cæcum, and the ascending colon were almost exactly in the median line. The appendix was lying over the tumor almost at right-angles to the incision, and held there by adhesions. Everything else was crowded to one side.

In reply to the suggestion of Dr. Tiffany, I am sure that the kidney had functionated to a certain extent early in life. The appearance of the kidney and ureter indicated that such had been the case.

STRETCHING OF THE FACIAL NERVE.

Report of a New Case, with Remarks, and a Summary of Previously Reported Cases.

By WILLIAM W. KEEN, M.D.,
of Philadelphia;
Professor of Surgery in the Woman's Medical College of Pennsylvania;
Surgeon to St. Mary's Hospital.

I desire to report the following case of right facial spasm, which existed for five and a half years; and in which resection of the right infraorbital nerve was performed with temporary relief; after which stretching of the facial nerve was done, followed by cure, with lessening paralysis of the face up to date of report.

Mrs. A. S., native of England, aged forty-eight years, four feet seven and a quarter inches in height, weighing 138½ pounds, and by occupation a housekeeper, was sent to the surgical clinic at the Woman's Hospital, April 1, 1886, by Dr. Wharton Sinkler, for operation, with the following history:

Family: Mother died of dropsy at the climacteric. Father died of inflammation of the stomach. Two brothers were killed in the war. One brother living, but not in good health.

Personal: Had nervous trouble when she was a child. Was paralyzed, and unable to walk until she was six years old, when she was brought to this country, and the sea voyage seemed to restore the tone of her nervous system. When twelve years old was again troubled with loss of nerve power: could not hold anything in her right hand. This condition yielded to remedies in a short time.

The menstrual function was established at sixteen years of age. The periods have always been accompanied by a profuse discharge, and a good deal of pain; they were always regular until about five years ago, when her present nervous trouble began, since which time they recur every two or three weeks, accompanied by an exaggeration of the nervous twitching and pain in the head and arm.

From the age of sixteen until five years ago she had no recurrence of nervous trouble, was always healthy, except an occasional sick headache, and twice an attack of chills and fever.

She was married at eighteen years of age, and has had ten children, nine of whom are living. Six months after the birth of the youngest, now nearly six years old, she noticed a drooping of the right upper eyelid, and soon after a twitching of the under eyelid, and the eyeball was quite bloodshot. Was under treatment for some time without relief. In less than six months the entire right side of the face and the right platysma-myoid twitched constantly; the angle of the mouth was drawn down and there was constant pain in the head. Talking, eating, and indeed any physical or mental effort increased the spasms. The twitching of the cheek against the teeth made it sore, and the cheek was often caught between the teeth in mastication, so that long since she had all the teeth in the right half of the mouth removed, without any effect on the spasms. She has been under Dr. Sinkler's care from July 23, 1883. Galvanism has been faithfully used, as also other remedies such as conium, gelsemium, cannabis Indica, eserine, nitro-glycerine, iodide of potassium, etc., with no permanent effect. Conium had marked influence on the tic when pushed to full doses, but soon lost its effect. Quinine would relieve the pain in the head when severe. April 25, 1884, pain in the right leg began, and at times there was pain in the back of the neck and arms. February 2, 1885, she complained of twitching in the right leg.

In June, 1884, the right infraorbital nerve was resected by Dr. T. G. Morton. About half an inch was cut out. This was followed by a cessation of all the twitching of the muscles, and the pain in the head was relieved. This relief continued a few days, but by the end of six weeks all the twitching returned, and, in addition later, a twitching of the right side and leg. Dr. Sinkler now sent her to Prof. Keen to have the nerve stretched, as had been agreed would be proper.

Physical Examination. Lungs—vesicular murmur good. Heart—mitral regurgitation—murmur heard at the apex and in the axillary space.

Urinalysis. Specific gravity 1.028. Color, yellow-white—white deposit. Reaction strongly alkaline, no albumen, no sugar.

April 1, 1886. Present State. Entered the hospital in condition before described. The nervous twitching increased when she was addressed or when she tried to speak. Whether her face twitched during sleep could not be determined, as she awakened on the slightest noise. Given an oil injection in the afternoon in preparation for the operation.

2d. Bowels loose, did not sleep very well through the night. *Operation.* Began etherizing at 1 o'clock, April 2, Dr. Sinkler present and assisting. At 1.10 an angular incision was made two and a half

inches long. The angle of the incision was at the apex of the mastoid process, the two lines passing upward behind the ear, and downward in a line parallel with the border of the sterno-cleido-mastoid muscle. Ligated the posterior auricular artery. The parotid gland was dissected and pushed forward till the prevertebral muscles and their aponeurosis were reached. A very weak current of electricity was then applied by a wet sponge to the cheek and a fine wire to various points in the wound until the nerve was found. Immediately a spasm of the facial muscles followed the application. The nerve was then laid bare. A hook was next passed under it and the nerve stretched several times from the face outward, pulling the head over to the right side. When the nerve was stretched, marked contraction of the facial muscles was seen. The force used was estimated at between four and five pounds. No more force was used because a few fibres were felt giving away when an attempt was made to lift the head. Horsehair drainage was used and four silver sutures were introduced. Complete paralysis of the facial muscles was noted after the stretching and before she had recovered from the ether. Upon recovering consciousness the patient remarked the absence of pain in the head.

Before the operation: pulse 90, temp. 98.8°. After the operation: pulse 82, temp. 98.6°.

A carbolized gauze dressing was applied and the operation was completed at 1.50 P. M. On coming out of ether she had four nervous chills. Was given a five grain assafœtida suppository, which quieted her. Took a dessertspoonful of milk or beef-tea every twenty minutes or half hour through the afternoon. At 6 P. M. complained of severe pain in the ear, which soon passed away. At 7 P. M. vomited, otherwise retained all nourishment. Took short naps through the afternoon and evening. After the operation there was complete paralysis of the facial muscles. The right eyelid did not close of itself. Slept very well through the night, snoring loudly.

3d (1st day after operation). 6 A. M. pulse 77, temp. 99.4°. Paralysis of facial muscles not so marked as immediately after the operation. No pain in the head, but she complains of a soreness in the right side of leg, which was rubbed with liniment. Took from half an ounce to an ounce of milk every hour, with some coffee. At 1 P. M. pulse 86, temp. 100.4°. Gave four grains of quinine. The wound was dressed at 2.30 P. M., slight oozing was found on the dressing. At 4 P. M. pulse 96, temp. 100.4°. Felt very comfortable all day and slept soundly all night.

4th (2d day). 6 A. M. pulse 85, temp. 98.6°. Took more nourish-

ment at longer intervals. Had no pain in the ear. 4.30 P. M. pulse 81, temp. 99°. Leg and side still painful, rubbed with liniment.

5th (3d day). 6 A. M. pulse 85, temp. 98.7°. Slept very well through the night, did not snore as on previous nights. Eyelid nearly closed, and facial muscles seem a little less relaxed than before. There has been no twitching of the facial muscles of platysma or leg since the operation. Sat up with bed-rest for an hour in the morning and for twenty-five minutes sat in rocking-chair in the afternoon. 4.30 P. M. pulse 80, temp. 98.6°.

6th (4th day). Temp. 98.4°, pulse 76. Hunyadi water for slight constipation. Out of bed. All the stitches removed this afternoon and the horsehair drainage—a few drops of sanious discharge followed. Bandage removed and adhesive plaster applied. Evening temp. 99.6°, pulse 74.

7th (5th day). Temp. 98.8°, pulse 73. Complained of pain behind her ear. There was a little discharge through the night. Applied a compress of absorbent cotton with iodoform sprinkled upon it.

8th (6th day). A. M. temp. 98.4°, P. M. 98.4°. Very little discharge.

9th (7th day). A. M. temp. 99.9°, pulse 73. Able to masticate. Given an enema. Bowels moved. Evening temp. 99°.

Was taken unwell. At this period previously the twitching of the face and also of the right side and leg, as well as the pain, were always much worse. All of these are now entirely gone. Neither twitching nor pain is present anywhere.

10th (8th day). Discharged well.

27th (25th day). No twitching or pain. Still complete paralysis, though the eye can be nearly closed.

September 10, 1886, five months after the operation, the patient remains well. The facial palsy has almost entirely disappeared, and the face has nearly regained its normal expression.

I append the following electrical examination made with great care by Dr. G. Betton Massey:

"The under-mentioned muscles of expression of the right side of the face were examined on the tenth day after you had operated—that is, on the 12th of April, and also on the seventeenth and twenty-fourth days after operation. A control examination was at the same time made of the sound side for comparison, and the figures found are placed in the table as the normal formula of each muscle.

"Farado-contractility was found greatly weakened on the tenth day, and totally abolished on the seventeenth. The galvanic responses tabulated below were noted with great care, all errors from changes in resistance being eliminated by the use of a milliampère meter (Barrett's). They were those produced by the minimal current strength at closure of the circuit.

"It will be noted by a reference to the table that the frontalis showed the serial change indicative of reaction of degeneration in a slight degree on the seventeenth day. This remained the same on the twenty-fourth, when slight modal change, consisting of a slow wave-like contraction instead of a sharp, quick one, was noted. The orbicularis palpebrarum showed quantitative diminution of excitability on the tenth day, and serial change on the seventeenth. The levator labii superioris showed slight serial change on the tenth day, which has increased since, amounting on the twenty-fourth day to more than a complete reversal of the normal figures. This was true also of the zygomaticus major, orbicularis oris, and levator menti, in all of which increasing serial change has been found, together with great modal alteration of contraction. The lower muscles of the face show greater change than the upper."

Minimal.		Contraction at		Remarks.
		Kathodic closure	Anodic closure.	
Frontalis	Normal	1	1½	
	10th day	1	1½	
	17th day	1½	1	
	24th day	1½	1	Slight modal change.
Orbicularis palpebrarum	Normal	½	1	
	10th day	2½	3	
	17th day	2	1	
	24th day	2½	1½	Slight modal change.
Levator labii superioris	Normal	2½	3	
	10th day	2½	2½	
	17th day	4	2	
	24th day	3	1½	Modal change.
Zygomaticus major	Normal	2½	3	
	10th day	2½	3	
	17th day	5	3½	Modal change.
	24th day	2½	1½	Great modal change.
Orbicularis oris	Normal	2½	3	
	10th day	2½	3	Slight modal change.
	17th day	1½	1½	Great modal change.
	24th day	1½	1½	Great modal change.
Levator menti	Normal	2½	3	
	10th day	2½	3	
	17th day	1	1½	Great modal change.
	24th day	1	½	Great modal change.

The subsequent history, with the later electrical changes, I shall report at future meetings of the Association.

Table of the Recorded Cases of Stretching of the Facial Nerve.

No.	Reporter and method.	Reference.	Date.	Sex, age, and side.	Duration of disease.	Supposed cause.	Temporary result.	Final result	Remarks.
1	Baum. (Baum's method.)	Berliner klin. Woch., 1878, No. 40, p. 595.	July 20, 1878.	F. 35 L.	6 years.	Epileptic fit.	Paralysis disappeared in half an hour; cure for 8–9 mos. Slight return after 8–9 months, another later. After two years so nearly well as not to need a second operation.	Great improvement two years after operation.	Right side occasionally twitched.
2	Bernhardt. (Hahn operated. Baum's method).	Zeitschr. für klin. Med., 1881, p. 96.	Nov. 15(?), 1878.	M. 36 R.	5 years +	?	No paralysis resulted; twitching returned next day. After two years, all in all, some improvement; often free for hours, at which times active movements do not arouse the spasms. Improvement not sufficient to encourage him to undergo a second operation.	Some improvement two years after operation.	Pain preceded the spasms for two years. No electrical difference on two sides.
3	Schüssler. (Baum's method.)	Berliner klin. Woch., 1879, No. 46, p. 684, and Godlee's table in Trans. Clin. Soc. xvi. p. 227.	Jan. 23, 1879.	F. 39 L.	8 years.	?	Paralysis for six weeks, disappearing at twelve weeks. Slight return after six months, and growing worse, but in nothing like the previous severity.	Some improvement six months after operation.	
4	Eulenberg. (Hueter operated, Hueter's method.)	Centralbl. für Nervenheilk., 1880, No. 7, and Godlee's table.	Dec. 2, 1879.	F. 27 L.	2 years.	?	Paralysis for three months, then slowly disappeared, and as it disappeared the twitchings returned, but never so violent as before	Some improvement three months after operation.	Chiefly sudden and severe blepharospasm extending to left side of face, and slightly to right side; also to some spinal accessory muscles and flexors of hand and fingers. Schirmer had stretched and divided left supra-orbital nerve without result. Posterior auricular nerve not paralyzed by Hueter's operation. Reaction of degeneration followed the operation. Loss of taste in left anterior half of tongue for fifteen weeks.

5	Putnam. (Baum's method.)	Archives of Med., N. Y., Feb. 1881.	April 24, 1880.	M.	25	R.	3 years.	?	Paralysis disappeared after three months. Spasms returned after nearly a year.	Unrelieved nearly a year after the operation.	Reaction of degeneration had begun on fourth day when first examined electrically, but this disappeared after nine months
6	Bernhart. (Langenbeck operated Hueter's method.)	Zeitschr. klin. Med., 1881, p. 99.	June 18, 1880.	M.	21	L.	4 years.	Cold	Complete paralysis three days Nearly gone in three months. Gradual return of spasm thereafter, but not so severe as before.	Somewhat relieved four months after operation.	Patient would willingly submit to a second operation as the paralysis was the lesser evil. Reaction of degeneration. Only branches to eye and upper face stretched.
7	Sturge and Godlee. (Godlee operated Baum's method.)	Trans. Clin. Soc., London, 1881, xiv. p. 44, and 1883, xvi. 229.	July 20, 1880.	F.	72	R.	6 years.	Mental shock.	Paralysis nearly disappearing after three months Slight unconscious twitching after three months. At end of nine months, following severe emotional disturbance, entire return.	Unrelieved three years after operation.	
8	Southam. (Baum's method.)	Lancet, Aug. 27, 1881, and April 10, 1886.	March 28, 1881.	F.	59	L.	2 years.	Fright.	Paralysis disappeared at sixteen weeks.	Cure after five years.	
9	Hoffmann.	Bernhardt, Deutsch. med. Woch., 1882, No. 9, and Godlee's table.	March 28, 1881.	F.	35	R.	.....	?	Paralysis lasted to some extent till the fall of 1881. At this time, while she was pregnant, and after delivery, spasms were worse, but then subsided (entirely?).	Cure or great improvement twenty-five months after operation.	Under lip and platysma branches too deep, and were not stretched.
10	Godlee. (Baum's method.)	Trans. Clin. Soc., London, 1883, xvi. p. 220.	Nov. 10, 1880, left nerve; March 24, 1881, right nerve.	M.	36	R. L.	3 years.	.....	Paralysis of both sides; began to disappear, after twelve weeks, on each side. As control returned, spasms recurred.	Unrelieved two years after operation.	Left supraorbital nerve was divided Sept. 13, 1881, for tenderness, but without good result.
11	Navratil.	Chir. Beiträge, S. 10. Quoted by Zesas; *vide* infra.	May 15, 1881.	F.	?	R.	7 years.	.....	Slight twitching for three days, then disappeared.	Unknown. Not seen later.	Slight attack of erysipelas.
12	Putnam.	Godlee's table.	June 1, 1881.	F.	45	L.	9 years.	.....	Entire paralysis for two months or more. After several months spasms reappeared.	Unrelieved after some months.	Supraorbital nerve had been divided fruitlessly.

TABLE—*Concluded.*

No.	Reporter and method.	Reference.	Date.	Sex, age, and side.	Duration of disease.	Supposed cause.	Temporary result.	Final result.	Remarks.
13	Southam. (Baum's method.)	Lancet, Oct. 8, 1881, and Godlee's table.	Aug. 1, 1881.	F. 32 R.	4 years.	.....	Paralysis present after three months, but fading.	Cure three months after operation.	
14	Benedikt.	Wien. med. Presse, 1882, Nos. 13 and 14.	July 2, 1881.	.....	Old.	.....	An old paralysis was followed by secondary tic convulsif for which the operation was done. The lagophthalmia vanished in the eight days of healing. Faradic contractility which had been absent reappeared, and the galvanic approached normal.	Improvement about three weeks after operation.	Operation was difficult, as it was through the scar of old glandular inflammation; nerve was found thin and gray, and degenerated.
15	Bernhardt. (Hahn operated.)	Berliner klin. Woch., 1882, No. 14, and Deutsche med. Woch., 1882, Nos. 9 and 29.	Aug. 1881.	F. 35 L.	3½ years.	Persistent drawing with a lens. See remarks.	Paralysis disappeared entirely in five months; twitching began after seven months; after ten months considerable twitching, but not so bad as before.	Improvement ten months after operation.	Posterior auricular nerve not paralyzed; reaction of degenerat'n [Godlee says it "followed *lupus* which caused contraction of eyelids." Bernhardt says it followed "nach anhaltendem Zeichnen *mit der Loupe* wobei das linke Auge besonders angestrengt wurde," An amusing error of translation.]
16	Gray. (Baum's method.)	Proc. Med. Soc. King's Co., N. Y., 1882, vii. p. 127.	May 8, 1882.	M. 36 R.	16 years.	.....	This was a case of tic douloureux preceded by tic convulsif; pain relieved for four days, then worse than ever; twitching lessened; paralysis.	Unrelieved as to pain; twitchings improved after three months.	Reaction of degeneration.
17	Gray. (Baum's method.)	do.	June 16, 1882.	M. 22 R. (L.)	10 years.	.....	Only right side stretched; paralysis.	Cure three months after operation.	Both hands also choreic. Reaction of degeneration.
18	Zesas.	Wien. med. Woch., 1884, No. 2; and 1885, No. 27.	Nov. 16, 1882.	M. 37 R.	8 years.	Cold.	No paralysis followed; spasm lessened, and ceased Jan 4, 1883 [seven weeks]. July, 1885, still cured.	Cure two years and eight months after operation.	No electrical change.

19	Bernhardt. (Levy operated.)	Archiv für Psychiatrie und Nervenkrank., 1884, xv. p. 777.	Jan. 16, 1884.	M.	25	R.	4½ years.	Cold.	Had paralysis of right face when first seen; after operation paralysis much diminished by April 1, 1884. By May 8, spasms returned almost as bad as ever. Voluntary power over some muscles had returned.	Unrelieved of spasms four months after operation; previous paralysis somewhat improved.	Reaction of degeneration.
20	Kaufmann. (Hueter's method.)	Centralbl. für Chirurg., 1885, No. 3.	Sept. 16, 1884.	M.	61	R.	7 years.	Anger.	Incomplete paralysis; improvement for four days; on fifth day returned as bad as ever.	Unrelieved four months after operation	Only part of nerve stretched. On fifth day same nerve divided without result.
21	Keen. (Baum's method.)	Trans. Amer. Surg. Assoc., iv. p. 275.	April 2, 1886.	F.	48	R.	5½ years.	Nervous trouble coincident with climacteric.	Paralysis; not lessened when reported (25 days), and with no return of spasms.	Uncertain; too early to report (25 days); [five months after operation still cured; paralysis nearly disappeared]	Reaction of degeneration on tenth day. Infraorbital nerve had previously been stretched without permanent relief.

Of these 21 cases there are males, 9; females, 11; unstated, 1. The right nerve was involved 11 times, the left 7, both 2, and side not stated 1. The age is from 21 to 72. Four of them had undergone previous operations (4, 10, 12, 21), the first three section or resection of the supraorbital, and the last of the infraorbital nerve, with no permanent effect.

Davidson (*Lancet*, 28, 1882) stretched the infraorbital nerve in a woman, æt. fifty-three, for muscular spasms limited to the muscles of the region supplied by this nerve. The spasms ceased in a fortnight. The case was reported about two months after the operation.

The most accurate tables heretofore compiled, though not free from errors, are those of Godlee and Zesas. That of Chandler (*New York Medical Record*, Sept. 9, 1882) is exceedingly inaccurate. Eulenberg has reported only one case, and there is no such case as that of "Germon," while the rose-colored views of the results are not justified by the facts. Dr. Harte, in Agnew's *Surgery* (vol. iii.) has used the tables of Chandler without verification (in that of mimic spasm at least), and has repeated its errors. Moreover, Harte's last four cases should be of the facial, and not the inferior dental nerve.

Remarks.—The operation of nerve stretching was first introduced by Billroth and Nussbaum in 1872. It has been done only twenty-one times upon the facial nerve so far as I have been able to ascertain. Five of these cases have been done in America (Putman two, Gray two. My own is the fifth). These twenty-one cases are summarized in the preceding tables.

Reason for the Operation. All of the cases have been for more or less extensive tic non-douloureux of the face, lasting from two to ten years. In two cases paralysis of the face preceded the convulsive tic, and in one case tic douloureux followed the tic convulsif. As Sturge has pointed out, the lesion in tic convulsif is probably central and not peripheral, though Kaufmann's curious case (see p. 286) would seem to show otherwise. In my own case the previous history points almost conclusively in this direction from the repeated and extensive paralyses. It might be objected, therefore, *in limine*, that the operation should not be done since it cannot reach the actual seat of the disease, and any interference with the nerve, the mere conductor of motor impulses, would have to paralyze the muscles permanently in order to effect the desired relief. The experiment of Godlee, in which he dissected out the spinal accessory and the facial and found that a slight pull on the former was immediately evident on the central side of the short, wide, and straight jugular foramen, while traction on the facial even to rupture of the nerve was not perceptible at the central end of the long, narrow, and curved aquæductus Fallopii, proves that no central alteration can be urged in favor of the operation on the seventh nerve, although in one case (4) taste was lost for fifteen weeks. But, *per contra*, while the expected paralysis nearly always follows, it always disappears in time, as I shall show, and the relief of the tic that has followed in a good proportion of the cases, gives a reasonable ground for the operation.

Method of Operating. Two methods have been proposed, that of Baum and that of Hueter. In the former the incision is made behind the ear by an angular incision two and a half inches long, the apex being at the apex of the mastoid process. The parotid gland is the first landmark. Its posterior border is

dissected and pushed forward by a grooved director and forceps till the shining aponeurosis of origin of the sterno-cleido is seen as the second landmark. The interspace between these two is cleared to the depth of one or one and a half inches, when the prevertebral muscles and their anterior fascial covering are the next landmark. The nerve lies in front of this fascia. Sometimes the posterior belly of the digastric is seen. The transverse processes of the vertebræ and the styloid process can both be felt and are valuable as additional guides. This space between the mastoid process and the vertical ramus of the jaw is quite narrow and deep. It will barely admit the finger. Hence a good side light is essential, and I found great help from a student lamp and a forehead mirror held by Dr. Sinkler, which illuminated the deeper parts admirably. The chief trouble is to find the exact spot at which the nerve crosses this space on its way from the stylo-mastoid foramen to enter the parotid. Dissection will always reveal it, but in order to avoid needless injury and abridge the search, I found the use of a weak faradaic current very useful. A strong current at any point in the moist state of the wound will produce muscular spasm at once, but a very weak current will only do so when the nerve is touched. A wet sponge was held on the cheek and the wire end of the other cord was touched at successive points till the nerve was easily detected, when its white trunk was quickly laid bare. While being stretched the extent of twitching produced by it should be noted to see whether the trunk has been stretched on the central side of all the branches. If any branches have escaped, the muscles supplied by them will not twitch when the nerve is stretched, and also, even during etherization, spontaneous convulsive movements will sometimes recur in the muscles the nerve branches to which have not been stretched, and so point out what branches have escaped.

The other method is that of Huèter by an incision in front of the ear two inches long, its middle at the level of the upper part of the lobule. The parotid is at once disclosed. The incision is carried more and more deeply till, at about three-quarters of an inch, one of the two main branches of the nerve

is reached. Further dissection will soon reveal the second branch and at their junction the main trunk. If it is desired to dissect back to the foramen, a second short incision at right angles to the first must be made posteriorly.

Of the two methods, that of Baum is by far the better. In the first place, its scar is hidden by the ear, and especially in a woman this is very desirable. Secondly, it is far less bloody: usually only the posterior auricular artery is cut, and possibly one or two other small vessels; whereas, in Hueter's, there are, usually, a number of glandular branches requiring ligature. Thirdly, much less damage to the gland and other tissues is inflicted. Fourthly, and chiefly, the nerve is reached directly at its emergence from the stylo-mastoid foramen before it has given off any branches except, possibly, the posterior auricular, an unimportant branch. How important this advantage is, is best shown by Kaufmann's case, in which he operated by Hueter's method. His first stretching disclosed the fact that he had not gone far enough back, for the frontalis and orbicularis palpebrarum were not paralyzed. Enlarging the wound upward and downward (it should have been backward) a second stretching gave the same result. On the fifth day the twitching was as bad as ever, and he wished to do Baum's operation, but the patient would not consent to a second scar, so he opened the original wound, found the injected nerve and divided it. The wound promptly healed, but no benefit resulted, and the patient went home worse than he came, for he not only had the twitching but his cheek and mouth were also paralyzed.

What light this case may throw upon the pathology of the disease I am hardly able to say. It certainly would seem to point to a peripheral cause for the spasms.

In Hoffmann's case also the muscles of the under lip and the platysma were not paralyzed, and in Eulenberg's and Hahn's cases the posterior auricular branch was not affected.

I have only had opportunity to compare the two methods upon the cadaver. The result of a score of trials is decidedly in favor of Baum's method, except in the case of performance from the less room and greater depth, in which particulars

Hueter's is the better operation. But these should not weigh in view of the reasons before stated.

The nerve being found, *how* shall it be stretched, *in what direction*, and with *what force?*

I have found an ordinary *blunt hook* an excellent means, and no other instrument seems necessary.

As to *direction*, I stretched it chiefly from the periphery toward the centre as well as the hook would allow, both because no stretching on the central end would affect the medulla, and because, as Marcus has shown, traction on the central end of a mixed nerve abolished sensibility while traction on the peripheral end abolished both motion and sensation, and the motor effect was here desired.

The *amount of force* to be used is as yet undetermined. Gray estimated it in his case at six to seven pounds; Southam at four to five pounds; and in my own case it was estimated at four to five pounds. It was not enough to lift the head of the patient (which would probably weigh six to seven pounds), for on carefully attempting to do this, before the head could be lifted I felt a few fibres giving way and I at once desisted. The head, however, was rolled from left to right quite forcibly.

Putnam records an interesting experiment on a dog. The facial has two branches, each about equal in size to the main trunk in man. One of these broke at forty pounds. A much less weight would have broken the nerve in my patient, and in several cadavera injected and condensed by the chloride of zinc the attempt to lift the head caused rupture of the nerve. The dog above alluded to was then allowed to come partially out of the anæsthesia and the other branch was stretched. At seven pounds the motion of the eyelid was impaired, a second pull of eight pounds produced complete palsy, which disappeared on the second day. Putnam recommends that the patient should be allowed partially to recover from the ether to judge of the effects of the pull, and that two pulls of about six and seven pounds be the limit imposed, unless symptoms be so severe that prolonged palsy be desired. My own impression is that this is

too great a force and that it can be best achieved empirically, the attempt being made to lift the head (six to seven pounds) and being abandoned the moment any fibres give way.

In Eulenberg's case the nerve was physically disorganized by the stretching, yet the paralysis disappeared in three months and the spasms returned, though with abated force. Schüssler states that in his case, after three or four pulls, the nerve lay in a small loop in the cavity of the wound, yet the palsy disappeared in twelve weeks and the spasms partially returned after six months.

The effects of slight and of severe stretching differ materially. As has been shown by Haber, Ranke, Cornet, and others, slight stretching either has no influence on the irritability of the nerve or even increases it, whereas greater stretching diminishes it or destroys it. Hence, in cases of facial spasm the stretching should be as severe as the integrity of the nerve will allow. And again the fact that the motor function of a mixed nerve is last lost is an additional reason for the maximum stretching that the nerve will bear. As Weir Mitchell also has shown that a nerve stretched to one-fifth of its length lost its mechanical irritability but not its electrical, but that this last was lost when the stretching reached one-quarter of its length, this is also another reason for the greater degree of stretching. But this stretching should be gradual and not sudden.

The fact noted by Billroth that in crutch palsy, which is caused by direct pressure, the motor function is lost while sensibility remains, naturally raises the question as to whether pressure might not be advantageously substituted for stretching or, as in Baum's case, combined with it. Stretching first abolishes the sensory function, and the motor function last; while pressure reverses this and abolishes the motor function first. Zederbaum's careful experiments (*Archiv Physiol.*, 1883, p. 161) show that in the sciatic nerve of the frog moderate pressure increased the irritability, the maximum being reached at 500 grammes (a little over 1 ounce), but that at 900 grammes (nearly 2 ounces), it began to diminish, and was lost at 1700 grammes

(nearly 4 ounces). Baum is the only one who has used pressure as well as stretching, but the result was only a partial success.

The *after-treatment* is simple. A few strands of horse-hair suffice for drainage, and with antiseptic dressing, the case should be well in a few days. In my own case the patient was out of bed on the third day; all the sutures were removed on the fourth day, and she went home on the tenth day, having staid in the hospital voluntarily some days more than was absolutely needful. Her highest temperature was 100.4° on the day after the operation, being normal the next day. Rarely, if ever, should suppuration follow. In Godlee's first case the wound was not healed for six weeks.

I think it important to bandage the lower jaw for two or three days, to insure quiet while the wound is healing, and for the same reason to give only liquid food during several days in order to avoid the muscular effort and movements of mastication.

Results of the Operation. The operation is free from danger; no death has resulted; no serious complications, and, in fact, no serious illness. Paralysis of the facial muscles, more or less complete both in degree and extent, is always to be expected, indeed desired. But this paralysis has disappeared in every case after a few days, weeks, or months, and in two cases (15, 19) in which prior to the operation paralysis had existed, some degree of voluntary and electrical control was attained. Indeed, this fact, together with the experimental results before referred to as to the effect of moderate stretching in increasing nerve irritability, leads me to suggest that it would be highly proper in some obstinate cases of facial palsy, to stretch the seventh nerve moderately as a therapeutic operation.

In Cases 2 and 18 no paralysis resulted, and in Case 1 it disappeared in half an hour; yet, in Cases 1 and 2 there was decided permanent improvement, and in Case 18 a cure lasting for two years and eight months.

In such cases as have been examined electrically, the reactions of degeneration have been found, but these have diminished as the nerve was regenerated, and have disappeared after some months. This is also in accordance with the results of experi-

mental nerve-stretching in animals in which microscopic examinations have been made. More careful observations are, however, needed upon this point.

As the paralysis has disappeared and the nerve has regenerated, in not a few cases the spasms have returned, while in others the relief has extended over years. Hence, the operation may be regarded from two points of view: (1) as giving temporary relief (palliative) and (2) as giving permanent relief (curative).

As a *palliative operation* the result has been as follows:

Case 1. Absolute relief for eight or nine months. Since then great relief (two years).

Case 2. Absolute relief for one day. Since then slight improvement (two years).

Case 3. Absolute relief for six months, then return of spasm in lessened severity.

Case 4. Absolute relief for three months, then spasms returned with lessened severity (three years and two months).

Case 5. Absolute relief for nearly a year, when spasms returned.

Case 6. Absolute relief for three months, then gradual return of spasms in lessened severity (four months).

Case 7. Absolute relief for nine months, then return as bad as ever (three years).

Case 10. Bilateral operation. Absolute relief for twelve weeks on both sides, then return of spasms (two years).

Case 12. Absolute relief for some months, then spasms returned.

Case 14. Absolute relief for seven months, then spasms returned in lessened severity (ten months).

Case 15. Great improvement for three weeks; prior paralysis lessened.

Case 16. Tic douloureux and convulsif both; pains relieved for four days, then worse than before; spasms somewhat relieved.

Case 19. Absolute relief for four months, when spasms returned with lessened severity.

Case 20. Absolute relief for four days; on fifth day as bad as ever (four months).

Or, in brief, fourteen cases with

1. Absolute relief under a week; three cases followed by improvement for two years in one case and no improvement in the other two.

2. Absolute relief three weeks to four months; five cases followed by improvement in four cases, and no improvement in one.

3. Absolute relief four months to a year; six cases, followed by improvement in three, and no improvement in three.

As a palliative operation only, therefore, it is well worth doing, since at no risk of life and but little suffering the relief is often prolonged, and if the spasms return it is with lessened severity. Indeed, my own patient would gladly undergo it again for even the brief respite so far assured, and far prefers a permanent paralysis to the persistent spasms.

As a means of *permanent cure* we have the following:

Case 8. Absolute relief for five years.

Case 9. Absolute cure or very great improvement (it is not quite clear which) for twenty-five months.

Case 13. Absolute relief for three months when last reported.

Case 17. Absolute relief for three months.

Case 18. Absolute relief for two years and eight months.

Or, in brief, two cases of relief, when last reported, for three months, and three of relief for from two to five years.

Of the remaining two cases, Navratil's (11) was only followed for three days, and in my own (21), though the result is perfect so far, yet, as it is only twenty-five days since the operation, it is too recent to classify. [Still cured as the proofsheets are corrected, five months after operation.]

It would seem, therefore, that whether viewed from the point of palliation or of cure, with our present knowledge, the operation is to be looked upon favorably. Further observation may show its inutility, but when we consider the utter hopelessness of improvement, much less recovery, from any other means,

relief by this operation, even if temporary, is had at a very trivial cost, and would be welcomed by any sufferer, while permanent cure is not impossible.

DISCUSSION.

Dr. L. McLane Tiffany, of Baltimore.

The temporary interference with the function of a nerve and the restoration of the same to its natural powers, which is what stretching is done for, has of late years attracted considerable attention; but the facial nerve is the only one which has been stretched for the arrest of motion. The points made by the essayist were so extremely well made as to leave nothing to be said. The outcome in his case has up to the present time been most fortunate, and we shall hope that it will be as fortunate as in the other cases, that there will be a long period of relief.

I was somewhat in doubt why the infraorbital nerve was excised. This, I believe, was done by another operator. I did not understand that there was so much pain as to justify that.

In regard to the incision. I have done the operation only on the dead body. On the cadaver there is theoretically no comparison between the two methods. The plan adopted in this case is incomparably the best. It leaves no scar, there is little hemorrhage, and the nerve is reached as easily as by the other plan. The use of electricity was extremely effective and is well worth adopting in other cases. The use of the mirror to throw light into the wound was most happy.

Dr. T. F. Prewitt, of St. Louis.

I have listened to the paper with a good deal of interest and I am sorry that I did not hear it earlier. Within the past year or two, I have met with a case of twitching of the face, where the twitching was limited. I remarked to Dr. Keen, in talking over this subject, that it was rather a formidable operation to stretch the nerve for a limited tic. There, however, seems to be no special harm resulting from the operation. I believe that the paralysis has invariably passed off after a greater or less length of time. It has been suggested that in a case of limited twitching the stretching should be confined to certain branches. That would, I think, be objectionable, because it would leave a scar. I

should prefer stretching of the whole nerve and trust to the chance of restoration after a time. The incision could then be made where it would not attract attention. The operation might forestall involvement of other branches. This is an interesting subject, but one to which I have not given special attention.

Dr. B. A. Watson, of Jersey City, New Jersey.

The thorough character of the paper leaves little to be said on the subject of nerve-stretching. That the operation was justifiable, even for the purpose of affording temporary relief, there can be no doubt. This is a comparatively recent operation and one with which we are not yet thoroughly familiar. We know little of the changes to which the cure is to be attributed. We have the fact that stretching of the nerve, if that stretching be continued sufficiently long—that is, carried to the proper degree—will produce paralysis and relieve pain. That nerve-stretching is useful, particularly in cases of neuralgia and also in certain cases of epilepsy and in certain spasmodic affections, has, I think, been demonstrated. Whether the relief is due to the gross changes in the nerves, or whether it is due to the molecular changes, or whether it is due to the gross and molecular changes, has, I believe, not been thoroughly determined.

In this particular case it would seem that elongation of the nerve possesses advantages over neurectomy. The latter operation would leave a more extensive scar and therefore would be objectionable, especially in ladies. Neurotomy gives but temporary relief, even in the successful cases. In those cases where neurotomy has been performed upon the facial nerve the relief has been of only a few days' duration, or at best only a few months. Neurectomy has given better results, but in most cases the relief is only temporary. It may continue for a number of years or only a number of months. It seems that the degree of relief afforded by neurectomy is dependent upon the amount of nerve tissue removed. A longer period of relief generally results from elongation than from simple neurotomy. In all the cases of neurectomy, as generally performed, there is more or less stretching of the nerve. In the case reported to-day, it seems almost marvellous to me that so much relief was afforded. It seemed as though in that case we had certainly to do with a neuralgia of central origin. Notwithstanding the fact that the neuralgic trouble had previously manifested itself in different parts of the body, it has for a time disappeared.

In the surgical treatment of neuralgia, then, we have to depend on simple neurotomy, neurectomy, or nerve elongation. Whether one or the other method is adopted in a particular case, must depend upon the comparative merits of the operative procedure in each individual case. I can only commend this paper. I am not prepared to enter upon its thorough discussion. I have never performed the operation of elongation of the facial nerve, although I have performed it on the nerves of the extremities, and have seen certain advantages from it in these cases. I wish to commend the method adopted to find the nerve. The use of electricity was most fortunate, and may be found of service in similar operations.

Dr. JOHN B. ROBERTS, of Philadelphia.

There is one point which is of interest to me in connection with an unimportant case which I reported to the Clinical Society of Philadelphia. I rise to ask Dr. Keen's appreciation of it as bearing upon the operation described. A man came to me stating that he had a curious condition of the face over the parotid region. When he began to chew, he had a transudation of fluid upon the skin over this region. As Dr. Keen read his paper and discussed the anterior operation, it brought this case to mind. On close inquiry, I found that the patient had had some three years previously an abscess which had been opened. On examination, I found a scar in front of the lobe of the ear, in the position which Dr. Keen describes as the seat of the operation for reaching the nerve. On examining the interior of the cheek, I found that a small probe could be passed along Steno's duct. As the calibre of the duct was increased, the exudation of fluid upon the cheek disappeared. It seemed reasonable to infer that at the time of the occurrence of the abscess, there had been some injury to the duct. The man passed from observation and I have not seen him for a number of weeks. I thought that this transudation upon the face was saliva which had found its way into the sweat follicles and escaped externally. This, I believe, has a bearing upon the question of making the anterior incision.

Dr. KEEN. In reply to Dr. Tiffany's question why the infraorbital nerve was excised, I would reply that while in this case the chief trouble was from the convulsive tic, there was a certain amount of pain joined with it and, I presume, that it was for this that the operation was done. In regard to the use of electricity, I found, in many cases, when oper-

ating on the cadaver, some difficulty in determining the exact level at which the nerve crossed, and it was this that suggested the advisability of using electricity as an aid. I found that with a moderate current all the muscles of the face were thrown into action, but by weakening the current almost to its minimum, I was able to pick out the nerve with the greatest accuracy.

Dr. Prewitt has referred to cases of limited tic, and the question of operating on a part of the nerve or the whole of it. It seems to me decidedly preferable to stretch only that portion which is involved. I certainly should not be willing, were I the subject of such convulsive tic, to have the entire nerve stretched, involving palsy, more or less prolonged, of muscles that were perfectly healthy. If we have blepharospasm, or spasm of the muscles about the mouth and chin, only the nerves going to the muscles affected should be stretched. In such cases Hueter's operation would be the most desirable, as that reaches the nerve at its division into the chief branches. The upper branch could be stretched for blepharospasm; the lower for spasm of the muscles of the face. I think that there would be no danger of injuring the duct of Steno, for the incision is made directly in front of the ear through the substance of the gland, before the duct begins. In no case where Hueter's incision has been employed has there been any disadvantage from the mechanical disturbance of the gland. The case reported by Dr. Roberts brings to mind a case in which the seventh nerve was stretched. At the moment of stretching, at least a teaspoonful of tears poured out of the eye. There would seem from this to be some possible reflex connection between the seventh nerve and the secretion of tears. This is the only case in which such an occurrence has been reported. From Dr. Roberts's description, I think that this abscess was hardly high enough to have involved the seventh nerve.

Dr. Watson has referred to the question of the way in which nerve-stretching effects its results. I think that a large element is the actual gross, mechanical disturbance of the nerve-trunk, interfering with nerve conduction. A large element, I think, as has been pointed out by Dr. Putnam, is the physiological rest which is secured to the muscles, and at the same time we have the breaking up of a vicious habit. We all know our ordinary muscular habits which are so difficult to break up. If by arresting the nervous influence bringing about the habit, we can produce its cessation for a long time, the habit will be broken up more or less permanently. I presume that the nutrition

of the nerve is also affected, through the interference with the blood supply. As to the influence upon the centres, I think that there was none in this case.

The relief not only of the facial spasm, but also of the beginning convulsive movements of the right side and leg, was as surprising to myself as it is to Dr. Watson. I had no expectation of such a result. Certain it is that for twenty-five days the woman has been completely free from any annoyance of the kind.

I should like, in closing, to call special attention to the proposition that I made in consequence of the influence exerted by nerve-stretching on cases of preëxisting palsy of the face, whether it would not be well to try, in such cases, nerve-stretching to a moderate degree, with the view of increasing the irritability of the nerve subsequently. I think this suggestion well worth a trial, and I hope that such cases, if tried, will be reported to the Association.

TWO CASES OF CHOLECYSTOTOMY.

By CHARLES T. PARKES, M.D.,
PROFESSOR OF ANATOMY IN THE RUSH MEDICAL COLLEGE, CHICAGO, ILLINOIS.

One year ago I had the honor to present for your consideration a successful case of cholecystotomy. To-day I desire to occupy enough of your time to give the clinical record of two operations for gall-stones that had a fatal ending.

The cases are interesting in themselves; their relation will add something to the general consideration of the surgery of such cases, and will surely demonstrate the fact that obstruction in the gall-ducts is not always amenable to surgical treatment. They will also, in a measure, serve to illustrate the difficulties with which the surgeon must contend in cases in which the gall-bladder has atrophied or is undistended with fluid.

Mrs. W. applied to me in February last for relief from gall-stones with which she had been suffering during the last six years at irregular intervals. The lady was fairly well nourished, the tongue furred, temperature normal, and pulse under seventy per minute. The functions of the body were normally performed. The skin had a decidedly icteric hue, and the urine contained much bile. The alvine discharges were mostly always light gray, but somewhat bile-stained during the interval of attacks of colic. These attacks of gall-stone colic came on every week or two and were of great severity. Gall-stones were passed and found after many of the attacks. Some months previous to my seeing the patient, after a long horseback ride, she had an unusually severe attack of the old pain unrelieved by repeated hypodermic injections of morphine, which was followed by the passage of a large number of small-sized stones. After this she was free from attacks until February. She had sought for relief from her trouble during several years in all countries and from many medical men, and finally choose the resort to operation.

Palpation and percussion failed to locate any enlargement of the gall-bladder without ether or when fully anæsthetized. The incision

was made vertically from the tip of the ninth rib just outside of the linea semilunaris. A very thick layer of fat was cut through before muscle aponeurosis was reached, so much that it required a long incision to give working room. Upon opening the peritoneum no bladder was seen; the intestines gave much trouble before they were finally kept out of the way by crowding three large flat sponges into the wound and over them. The finger finally found the gall-bladder closely adherent to the under surface of the liver and much elongated. Its fundus was dense and thick for a distance of half an inch inward, when the walls seemed suddenly to assume their normal condition as far as the commencement of the common duct. In this thin-walled portion a number of stones could be felt. The common duct could be easily traced to the intestinal wall. It was thickened, and rolled as a dense cord between the thumb and finger. A stone of considerable size, the largest in the collection, was felt in its lumen about half way of its length, tightly compressed by the duct walls.

How best to proceed was the query, as the bladder could not be brought into the external wound. Finally the gall-bladder was detached from the liver by means of the finger, and being isolated a silk suture was passed deeply through the thickened fundus on opposite sides of the cyst as far removed from each other as was allowable. Then the fundus was cut midway between the sutures until the cavity of the bladder was opened. The tissues cut were fully half an inch in thickness, and the opening made readily admitted the finger into the cavity of the bladder, coming directly in contact with the stones, not however without tearing somewhat into the thin walls lower down. The forty-three stones here shown were removed, the largest found in the gall-duct was pressed back into the bladder with the thumb and finger and then secured. The opening in the sides of the gall-bladder were then closed with interrupted silk sutures up to the fundus, an opening being left at the tip through which a large-sized drainage tube was passed well into the cavity of the gall-bladder. After careful sponging the abdominal wound was closed in the ordinary way, the sutures nearest the tip of the gall-bladder being passed through its walls. The patient was under ether one and a half hours and was extremely prostrated. The anæsthetic acted badly from the first, producing severe vomiting and suffocation before the operation was commenced, and requiring a suspension of the operation several times afterward to resuscitate the patient. The pulse was about 130 after she was put to bed, and never fell below that figure up to the time

of her death, on the morning of the third day after the operation. The patient never fairly rallied from the shock of the operation and I certainly think that the bad effect of the ether in this case had much to do in producing the fatal issue. The common duct was so much thickened by inflammation, and its lumen thereby so much reduced in size that the concretions could not get through it. At the end of the first twenty-four hours it was necessary to renew a very massive dressing on account of its being absolutely saturated with a free flow of greenish fluid through the drainage tube. I feel quite sure that it could never have found its way through the natural channel.

The second case was under the charge of our president, Dr. Gunn, who honored me with an association with him in the operation on the patient, and very kindly granted me the privilege of giving you the following record of the case:

November 3, 1885. Mrs. H., fifty-one years, has been sick two years. Got frightened and was taken with pain in epigastric region, lasting about twenty-four hours, and since that time her skin has been greenish-yellow, as it now appears. Has now attacks of pain which last four or five days every week or two. Weight has decreased from 145 to 90 pounds. Is greatly troubled with itching. Troubled with nausea and gastric derangement. Stools of pale ashen color. The liver is enlarged, reaching down to umbilicus. Has never found any gall-stones in dejections, though always searched for. Diagnosis: biliary obstruction of some kind.

7th. Patient returned for examination. Previous diagnosis confirmed. Patient stated that four years ago, at night, had a very severe attack of pain which passed off; her physician said it was caused by gall-stones. Two years ago had a similar attack.

17th. Operation. An incision about four inches long beginning at lower border of ribs, over region of gall-bladder, extending vertically. Tissues and peritoneum carefully divided, exposing the liver, which was drawn upward, bringing its under surface within reach of the finger. The most thorough and diligent search, however, failed to discover the gall-bladder, the proper location for which was plainly outlined and felt with the finger, with reference to the transverse fissure and ligament, showing the entire absence of the gall cyst. But close to and partly encroaching upon the transverse fissures was found an elevated resisting tumor, the surface smooth and hard, the exact nature of which could not be determined, but probably containing biliary

concretion. It was too near the large bloodvessels to admit of any interference with it. This tumor seems to have so pressed upon the hepatic duct as to prevent the passage of bile, thus causing the shrinkage of the gall-bladder and its entire disappearance. The wound was closed with catgut sutures and dressed. Patient returned to Presbyterian Hospital. She died about twenty-four hours after the operation. Post-mortem examination revealed remains of the shrunken gall-bladder in the longitudinal fissure, but with no sign of gall in it. The induration contained a gall-stone which lay at the conjunction of the hepatic and common ducts. A small abscess was found in the small lobe of the liver. The peritoneal cavity was clean—no hemorrhage.

DISCUSSION.

Dr. W. H. Carmalt, of New Haven, Connecticut.

In connection with the cases reported I beg to relate one in which an operation was undertaken, and the conditions which were found, when I opened the abdominal cavity, differed greatly from those which were supposed to exist. A German woman, thirty-seven years of age, the mother of seven children, otherwise apparently healthy, came to me in the latter part of January last with the history that she had suffered for several years with severe pain and an undefined dragging sensation in the right hypochondriac region. She had, in March, 1883, sought advice at the university surgical clinic of Professor von Bergmann, in Berlin, and was there subjected to an operation of which she showed the evidence in a large scar in the lumbar region, four inches or more in length, and judging from its breadth it had been a suppurating wound. She had been told that she had a floating kidney and that it had been stitched to the side (Hahn's operation). She stated that three weeks later, while still in the hospital and enveloped in the dressings from chin to pubis, she had had a violent attack of sneezing, and immediately thereafter the dragging sensation and distress returned. She was told that the "kidney had broken loose." This was in April, 1883. She stated further that Prof. Martin, of Berlin, afterward advised her to submit to another operation, the nature of which, however, she did not give a clear account. She did not do so, but joined her husband in this country early in 1885. When she came under my observation, she described the symptoms to be very much as she had

felt them before. There was a dragging sensation in the right hypochondriac region, with pain so severe as to render her practically *hors du combat;* she was unable to perform the household duties incident to her station in life. She was sent to me by Dr. Fleischner, her family physician, for advice. The first noticeable feature in her case was a remarkably pendulous abdomen, which fell down almost to overlap her pubes when she stood up. There seemed to be no tonic muscular contraction whatever in the walls. A tumor was readily felt just below the free border of the liver and apparently separated from it by a distinct space in which we thought percussion gave a resonant sound. It could be grasped with the fingers and apparently lifted up from its position, but it glided readily from the grasp as a rounded body that could not be encompassed to the equator would, and the manipulation caused considerable pain. The position of the tumor changed with change in the position of the patient, dropping two and a half inches when the woman was in the erect posture. By slight pressure, it could be pushed further back into the abdomen. There had never been any symptoms of gastric irritation, or any form of dyspepsia, or of the passage of gall-stones, and no trouble with the function of the liver was remarked. The patient was kept under observation and the urine examined daily for a month. It was a little over the normal quantity, but it presented nothing abnormal by chemical or microscopic analysis. The patient desired an operation to be enabled to help her husband instead of being a burden to him, and was willing to take all the risks. A consultation was held, at which opinion was divided. One gentleman thought that possibly the tumor was connected with the gall-bladder and advised against interference, thinking that a supporter might be arranged which would give relief. I tried several, however, without any success. At last I made up my mind that the kidney was involved and that nephrectomy was the only means that would give relief.

With the assistance of Drs. Beckwith and Fleischner, I operated, under careful antiseptic precautions, using an irrigating solution of hydrargyri corrosivi chloridi, 1 to 4000. An incision, four inches in length, was made just external to the right rectus muscle and over the site of the tumor. Only one vessel required ligation. Dividing the peritoneum, I found myself face to face with a tumor, which certainly was not the kidney. It was of a light pink color, about as large as the fist, and projected beyond the edge of the liver. It fluctuated unmistakably. It was firmly attached to the liver, which overlapped it a little and projected into the wound. It was evident that I had to deal

with the distended gall-bladder. I introduced an aspirating needle and drew off four ounces of thick whitish mucus. The point of the needle detected the presence of some hard substance, so after evacuating all the fluid an examination with the finger showed that the gall-bladder contained calculi. Having passed two ligatures into the gall-bladder, I made an incision between them and found a gall-stone as large as the end of my thumb. This was removed, and I then found three others. By manipulation these were brought to the most accessible part of the gall-bladder. One was broken by the forceps in the process of extraction. One of them was at the orifice of the cystic duct and required considerable effort to dislodge it. The gall-bladder was then irrigated with the sublimated solution, as also all the parts of the abdominal wound, and the incision in the gall-bladder closed with a continuous catgut suture, inverting the mucous surfaces and bringing the serous surfaces into close contact. The peritoneal wound was also united by a continuous catgut suture, the muscles by deep interrupted silk sutures, and beside these a continuous catgut suture was used in the incision in the skin. The wound was dressed with borated cotton and the patient put to bed. The operation lasted one hour and fifteen minutes and was followed by no unfavorable reaction. The patient recovered without the temperature ever going above 101.2°, and that but once. The wound united by first intention throughout, except that there was suppuration in the track of one of the interrupted sutures of black iron-dyed silk.

The patient is now attending to her duties. I saw her five days ago working hard on her knees scrubbing. She said she had not felt so well for many years.

During the operation, in order, if possible, to find out what had been done at the previous operation, I passed my fingers far down into the abdomen and detected, as I think, the right kidney in its proper position. Whether it was ever stitched there or not, whether the first operation was successful and this was something entirely different, I do not know.

Dr. PARKES. This case confirms the assertion which I have made that the surgeon has a very different thing to deal with when he does the operation for a distended gall-bladder, than when he does the operation where the gall-bladder is undistended. The difficulty of the operation is greatly increased. The operation of cholecystotomy proper almost always ends favorably.

SUBCUTANEOUS DIVISION OF URETHRAL STRICTURE.

By C. H. MASTIN, M.D.,
OF MOBILE, ALABAMA.

I HAVE selected as the subject which I shall have the honor to bring before the Association at this session, "Subcutaneous Urethrotomy in Close Organic Stricture of the Urethra." I do this for the reason that it has seemed to me better to discuss a question concerning which I had had a large personal experience, rather than to recite the observations of others, however interesting and important the latter might prove.

I fancy, at least, that the views I have to offer are not without importance, and I am convinced that they will not prove so familiar to you as many other topics which I might have selected. I shall, therefore, introduce to your notice, in the simplest and briefest manner, a running history of external operations upon the constricted male urethra, and then describe the operation which I have been induced to devise and adopt as the one which, to my mind, offers the best possible results in those cases of impassable stricture of the urethral canal which will not yield to the milder methods of dilatation, in one form or another, or to the operation of internal urethrotomy.

Organic urethral stricture becomes sometimes so difficult and so obstinate an affection to treat that we are forced to resort to other than the usual methods for its relief. Such being the case, it is not surprising to find that, from the earliest times, dangerous and difficult operations have been introduced for its cure, or rather for its immediate relief: among which are incisions made from the outside, through the integument and urethral wall, dividing all the diseased structures, and leaving the parts gradu-

ally to reunite. Such operations may all be embraced in the one general term "External Urethrotomy."

As far back as we have any recorded history of surgery, we find the ancient surgeons, like ourselves, encountering difficulties in the treatment of urethral stricture, and oftentimes unable to gain an entrance into the bladder through the natural channel. Hence, they were forced to resort to the use of the knife, by which incisions were made into and through the urethral walls. Celsus was evidently familiar with such an operation, for in Book VII., Chapter XXVI. of his writings, we find this passage:

"In suppression of urine, if the urethra is stopped by a stone, the prepuce must be drawn out as much as possible, and, the glans being covered, it must be tied by a thread; then, on one side, a longitudinal incision must be made into the penis, and after this the prepuce is let go; for by this means the sound part of the skin covers the incision in the penis, and the urine will be discharged in the natural way."

It is very evident that he certainly intended to speak of *retention*, and not *suppression* of urine, and that the incision was made in the urethra and not into the body of the penis. A natural inference to be drawn from this quotation is that, if Celsus advised opening the urethra to get rid of an impacted stone which was obstructing the flow of urine, he evidently would have advised a similar operation in a case of retention caused by any other obstruction, as, for example, stricture of the canal. Still later than the time of Celsus, we read in the writings of Rhazes in the tenth century, a clear description of such an operation having been done for obstruction of the urethra. Again, Avicenna, who wrote in the eleventh century, mentions puncture of the urethra through the perineum for the relief of retention of urine. These operations appear to have been intended solely to give exit to retained urine, but with no intention or proposed plan of curing the disease which caused or produced the obstruction; the object of the ancients being more the relief of the immediate symptoms than an endeavor to eradicate the disease.

The first reliable mention of an operation of which we have

any positive knowledge, which was performed for the cure of stricture, and not entirely for the relief of retention, is the one recorded by Richard Wiseman, in his work entitled *The Ill Consequences of Gonorrhœa.* Here he speaks of having witnessed, in the year 1652, an operation done by Mr. Edward Molins, "which," says Wiseman, "consisted of an incision into the urethra near the neck of the bladder, for retention of urine; that the knife did not readily divide it, for it was as hard as a gristle; the urethra being opened, the urine gushed out, and the wound remained fistulous." In this operation, if we fully understand Wiseman's description, the incision was made into the urethra posterior to the obstruction, and subsequently the incision was carried through the coarctation to its anterior face, a very similar operation to the "boutonnière," a proceeding of which we shall have occasion to speak more at length in the course of this paper.

Again, in the latter part of the same century, we find Soligen performing similar operations, once at Livourne, and again at the Hague. Then we hear of an operation, which was designated "la boutonnière," being done in 1687 by François Tolet, for the relief of retention, but not for the cure of stricture; and he tells us that it was an operation much in vogue "by men of great skill and reputation," and employed by them only in cases of great emergency.

Then, François Colot follows him, operating in 1690 for the cure of impassable stricture complicated with perineal and scrotal fistulæ. From that date onward we find, scattered here and there through the early literature of the profession, only references to the subject, until the year 1730, when Ledran operated upon "a case of organic impassable stricture;" this operation he did at two sittings," and after the following manner: The first day, the perineum was opened down to the urethra, and on the succeeding day he opened into the canal upon the anterior face of the stricture, through which, after gradual dilatation for five days, he passed a bougie on into the bladder; when this had been accomplished, he "slit up the urethra as far as the neck of the bladder." Gradual dilatation was then resorted to, by which

the entire length of the urethra was stretched open, and the patient is said to have gotten well.

About the same date, J. L. Petit, on numerous occasions, appears to have performed similar operations for retention of urine, and in some cases he divided the stricture at the same time, with the evident intention of curing the obstruction. Petit relates a case where he performed the operation for the cure of a stricture through which it was impossible to pass an instrument, although there was no retention of urine, and no fistulæ through which urine could find its way. He cut through the urethra at the face of the stricture, upon a grooved sound introduced down the canal to the seat of obstruction, after which he forced a trocar through the obstruction and into the bladder, following the supposed course of the urethra. He then slit up with a bistoury the strictured portion, tied in a catheter, and left the wound to heal by granulation, which it did in about a month or longer time, and the patient is reported as having been entirely cured. This was probably the first case in which a "sonde à demeure," or retained catheter, was ever used. Petit subsequently resorted to a similar operation in a number of cases, and states that, whenever he has performed "la boutonnière" (as he termed it) for retention of urine, his patients always "regained the freedom of the canal when he comprehended the obstacle itself in the incision." But he is very careful to remark that "the boutonnière is to be shunned whenever the introduction of a sound is practicable."

In 1750, twenty years after the operations of Ledran, Mr. Sharp, of England, described an operation very similar to his, "by cutting in *perineo* if possible upon a staff," and recommended its performance;[1] but, in 1782, we find him condemning it in no measured terms, and advocating in its stead the suprapubic operation for relief of retained urine, as one less to be feared, and less serious in its results.[2] Only six years after this date—*i. e.*, in 1788—John Hunter comes to the front, and

[1] "A Critical Inquiry," London, 1850.

[2] A Treatise on the Operations of Surgery, etc., by Samuel Sharpe, F.R.S., etc. Tenth edition. London, 1782. Chapter xv. pages 77, 78.

not only advises but urges the operation as the proper one for the cure of strictures complicated with perineal fistulæ; he himself having performed, in 1783, an operation in which he cut upon a staff introduced down to the stricture, and exposed the face of the obstruction, which was subsequently dilated so that the staff was with difficulty passed on into the bladder. This was neither new nor original with Hunter, for in the year 1738 both Astruc and Daran had described the operation as done by Hunter, and again in 1748 called the attention of surgeons to the method; but they both opposed and advised against its performance. In 1786 both Chopart and Desault performed the operation in various ways, but the mortality proved so great, and they denounced it in such violent terms, that very few surgeons could be found who were willing to attempt it. Desault writes:

"The operation known under the name of 'la boutonniére,' though apparently better adapted to the nature of the disease, is, almost always, either useless or dangerous. It is useless if the surgeon has been able to pass a grooved director for the purpose of operating, because in such a case he might just as well introduce a hollow sound. It is dangerous if the surgeon has no director to guide him, for then he makes his incisions at hazard, may miss the canal, and divide parts, the lesion of which is followed by more or less serious accidents."

Chopart having had no success with the operation, became bitter in his denunciations of the procedure; and the failures, together with the great mortality attending it, about the close of the last century, threw it into such disrepute, that very few surgeons could be induced to perform it. Mr. Sharp, of England, then condemned it, and very soon it fell into disuse in France, and was not again practised in England until about the year 1807, at which time Sir Charles Bell called attention to it as an operation peculiarly adapted to, and required in those cases of aggravated stricture of the urethra complicated by perineal fistulæ; still the operation did not receive favor in England, and we hear little or nothing more of it until the year 1817, when it was revived and introduced into America by the

late Dr. Alexander H. Stevens, of New York, who then operated successfully upon a case of stricture by this method after all other means of relief had failed. Then Dr. Jameson, of Baltimore, began to operate in 1820, and by the end of the year 1823 he had performed ten operations without a single death. This remarkable success with a hitherto unsuccessful operation naturally directed the attention of American surgeons to the method, and it was not long before it became popular in New York and other Eastern cities. Dr. D. S. Rogers, of New York, also began the operation in 1823, and very soon laid before the profession the report of twelve operations, all successful. By the year 1843 Warren, of Boston, March, of Albany, Hoffmann, Post, Watson, and Buck, of New York, with many other American surgeons, had, by large numbers of successful cases, all done without the use of a conductor, so fully established the propriety of the operation, that it at once became an accepted operation on this side of the Atlantic.

Carefully examining the reports of these cases, we find they were all performed after the method of the "old boutonnière;" that is to say, without a conductor, which goes to prove they were cases impassable to instruments. So, before we investigate the subject further, it may not be out of place to show what is meant by that term, and then analyze the methods which come under that general description.

This operation has been performed in so many ways that we are at a loss to understand the exact idea which the old authors wished to convey when they used the term "la boutonnière." The most explicit description which we have been able to find, is the one given by Desault in his treatise upon the diseases of the urinary organs; this is, to my mind, most clearly evident that the operation was performed in three ways: *First*, upon a conducting staff which was passed through the stricture and on into the bladder, upon the groove of which conductor the incision was made. *Secondly*, where a staff was passed down the urethra until it reached the anterior face of the stricture, and the urethra opened upon the point of the staff, after which the stricture, together with the integuments, were all laid open by

the knife upon a director which was introduced through the stricture *from its distal* opening. *Thirdly*, a staff was passed down to the stricture, and the urethra opened in the membranous portion posterior to the obstruction, through which opening a grooved director was passed *from the posterior face* of the obstruction forward through the stricture until it came in contact, or nearly so, with the end of the staff as it rested upon the anterior face of the coarctation; then a knife was pushed along the groove of the director from behind forward, and the entire stricture, together with wall of urethra and integuments, all ripped open: this last method is the one usual with French surgeons. This completes a running epitome of the operation from its early history, to the year 1849, when Mr. Syme, of Edinburgh, called the attention of the profession to "A New Operation for the Cure of Urethral Stricture:" a method which he had devised, and which consisted in passing a special staff through the stricture, then opening the urethra behind the coarctation upon the small grooved director attached to the staff; in this groove he passed a sharp, narrow-bladed knife forward through stricture, integuments, and all, laying the urethra freely open. It is, however, scarcely necessary to consume time by a long description of the method of the Scotch surgeon, or a detail of his cases, for I presume all are perfectly familiar with it.

It may not be uninteresting, however, to show what were the conclusions which he proposed to draw from his method; and it will serve my purpose better if I quote his own language on this point—they are as follows:

"1st. That there is no stricture truly impermeable, and that, with time and care in every case, an instrument may be passed through it, and serve as a guide for the knife.

"2d. That all strictures which cannot be remedied by simple dilatation, admit of effectual relief only through a free division of the contracted part of the canal.

"3d. That this object can be obtained with certainty and safety only by an external incision in a line corresponding with the raphé of the perineum upon a grooved director passed through the stricture.

"4th. That the only after-treatment required is the introduction of a catheter during forty-eight hours, with the subsequent use of a full-sized bougie at distant intervals.

"5th. That the operation, if properly performed, is free from any risk whatever of hemorrhage, extravasation of urine, or fistulous opening."

I shall examine these conclusions and see how far they may be fully received; whether or not, in the first place, the proceeding is entitled to be considered "a new operation;" how far, if in any particular, it differs from one of the varieties of "la boutonnière;" and, more important than all, whether it is free from danger. That it is not a new operation has been clearly proved by the description of the boutonnière by Desault. In his first division, he shows that the staff was passed through the stricture and the coarctation cut upon the groove of the same; in his third division, that the urethra was opened posterior to the contraction, just as Mr. Syme described it, a director passed from behind forward, and the stricture cut from its posterior to its anterior boundary. The director of Desault was passed from behind, whilst that of Mr. Syme was introduced from the front; this is the non-essential difference in the two operations, one of no consequence, since the stricture, integuments and all, were laid open and left to granulate after both operations.

Mr. Syme has assumed the non-existence of impermeable stricture, and says:

"There is nothing of more consequence in the treatment of stricture than the knowledge of the fact that this alleged impermeability has no real existence except in those cases where the urethra has been divided by violence and allowed to cicatrize with obliteration of the passage beyond the opening at the seat of injury. It is obvious, indeed, that if the urine is permitted to pass, no matter how small a stream, or even by drops, there must be room for the introduction of the instrument, if it be sufficiently small and properly guided.

Even this assertion is not new, since Mr. Liston had, in 1835, enunciated the same opinion, as shown by this language—"there are no strictures impassable that I have ever seen, for

where any water comes away, you can, by patience and perseverance, get a catheter through sooner or later." Still these assertions have not been proved, since we find in Mr. Syme's own work two instances in which he acknowledges that he was unable to pass his special staff, and consequently he was forced to open the urethra anterior to the stricture and then cut through the same, as in Desault's description of his second division of la boutonnière. Mr. Liston also has been repeatedly foiled in his attempts to introduce a catheter through an ordinary stricture, and was obliged to have recourse to an operation of tapping the bladder both above the pubis and also through the rectum. Yet Mr. Syme asserts that he has never been called upon to perform his operation for impermeable stricture, and simply because he had never met such a case. He makes permeability an indispensable prerequisite to the performance of external division, and does so upon the ground of the "*danger, uncertainty, and difficulty*" which, he asserts, must attend all operations done in the perineum in search of the urethra, without a guide. His own assertions are conclusive evidence that there are impermeable strictures, even if we had no better authority; but upon this point the united experience of almost all surgeons goes to show and to prove that there are cases of stricture oftentimes met with which are impassable to instruments yet not absolutely impermeable to urine.

2. His second conclusion is far from being sustained, since there are too many well-attested cures of resilient stricture—strictures which have proved rebellious to dilatation—which have been thoroughly relieved and permanently cured by the simpler operation of internal urethrotomy; thus sustaining the well-established fact that when a stricture is not impassable to instruments, external division is contraindicated.

3. If we can rely upon the testimony of Mr. Lizars—and his assertions have not been refuted—Mr. Syme's own cases were not with certainty and safety relieved. Mr. Lizars conclusively showed that the statements of Mr. Syme were not to be relied upon, since his cases had not been fairly or even correctly reported by himself, and that a large number of his operations

proved failures, since in many instances the patients were placed in a most terrible condition as the result of his method: profuse hemorrhage occurring in quite a number of them, and also extravasation of urine followed by extensive sloughing, terminating in numerous fistulæ. Mr. Syme himself acknowledges the dangers of the operation when he writes, giving the history of some "eighty or ninety cases," that "alarming symptoms were by no means rare, since every third or fourth patient suffered from rigors, vomiting, delirium, or suppression of urine."[1] Besides these troubles, he met with two fatal cases which he attributed to contact of the urine with the wound.

It is not the purpose of this paper to cast the least reflection upon the distinguished surgeon whose name has been so intimately associated with this operation, nor to condemn the operation of external section. I am writing its history, and desire simply to give the result of my investigations, and show what objections are sustained against it. It is certainly proved, that from the most remote times it has been considered a dangerous and difficult operation, and even in our own day, when surrounded by all the appliances of improved surgery, and encouraged by the success which has attended it, some of the best modern authorities pronounce it an operation not free from danger, but one which requires the most consummate skill for its successful execution.

The venerable, gifted, and distinguished founder of this Association, a man who made, and has left his impress indelibly stamped upon the surgery of the nineteenth century, used this forcible language when writing of the operation:

"The operation is by no means free from danger and requires the most consummate skill for its successful execution. None but a madman or a fool would attempt it unless he had the most profound knowledge of the anatomy of the parts, and a thorough acquaintance with the use of instruments. Of all operations of surgery, this is the least to be coveted."[2]

[1] Lancet, August 21, 1858, p. 191.

[2] S. D. Gross, Diseases, Injuries, and Malformations of Urinary Organs. Second edition, 1855, page 801.

The operation has not been fully accepted in France, and was rejected by a commission of the French Academy which was appointed to sit in judgment upon it. Civiale, than whom no sounder authority in matters pertaining to genito-urinary surgery has lived, himself never performed it, although he was known frequently to have had resort to the old operation of "la boutonnière."

With all the objections brought to bear upon the various operations of external section, still we are, as I before stated, sometimes called upon to relieve a patient from retention of urine caused by obstinate and impassable or impermeable stricture: and when that rare contingency does arise, and when milder measures have utterly failed, the urethra remaining absolutely impervious,—letting in no catheter, letting out no urine—then undoubtedly this condition will establish a necessity, a legitimate and imperative and urgent necessity, for our making an artificial vent for the discharge of the contents of the distended bladder.

This brings me to the consideration of the indications which render such an operation necessary.

Indications.—1st. The impossibility of passing a sound into the bladder through the urethral canal, when a firm organic contraction blocks up the urethra and proves rebellious to either dilatation or internal urethrotomy. Here we are imperatively called upon to relieve an over-distended bladder, else we find cystitis being developed, bladder walls becoming hypertrophied, ureters dilated, and kidneys disorganized. The nervous system, overwhelmed by the absorption of urea, cerebral symptoms speedily ensue, and the patient dies comatose. In such cases, the constitutional distress is urgent, and the demand for relief imperative; it then becomes dangerous to temporize with milder methods, and as a rational but *dernier ressort* we must perform an external section. But even in such cases it is not always necessary to do an operation through the perineum, or from without inward; for in some cases it is possible to cut down through the axis of the urethra into and through the stricture, although it may be impassable to the smallest instrument. Of

this I speak advisedly, since I have myself done such an operation upon several occasions where I was not willing to subject the patients to the gravity of an external section. It is true the operations were exceedingly difficult, yet they were completed with perfect safety and relief to the patients.[1]

2d. Infiltration of urine resulting in abscess may necessitate an external section. I do not here refer to those sudden cases where from direct injury the urethra has been ruptured and infiltration is the consequence, but I allude to those cases where a tight stricture has existed for a length of time; where a peri-urethral abscess has resulted from a small opening in the urethra behind the stricture, and the gradual infiltration of urine has lighted up inflammation to a degree sufficient to form a circumscribed deposit of pus. In such cases it is necessary to open the abscess for the purpose of relieving the sufferings of the patient. To do this more effectually, it will be well to carry the incision still deeper, and lay open the urethra at the site of rupture, then carry the knife forward through the stricture to the point of a sound introduced down to the anterior face of the coarctation.

3d. The third indication *might* be placed where certain cases of old tight strictures complicated with urinary fistulæ through which a great part of the urine escapes at every act of micturition.

Many surgeons contend that here is a clear and unmistakable indication for an external section, but, unless in some exceptional cases, I cannot give my unqualified assent to the proposition, since experience has clearly shown that in almost all cases of urethral fistula, so soon as the lumen of the canal is fully restored, the fistula heals; and very soon thereafter, when the normal calibre of the urethra has become established, the innodular tissue which surrounds the fistulous opening becomes absorbed. Such being true, I prefer an internal section as less dangerous and equally efficacious.

[1] For report of cases, see Richmond and Louisville Medical Journal, Sept. 1873, vol. xvi. page 285.

4th. The most important indication which may arise, is when the urethra has been ruptured by a violent blow, and when the effects of such injury are rapid and severe. In some of these cases serious results do not take place immediately after the injury; but in others, enormous extravasation of blood may occur immediately upon the reception of the injury—then retention takes place, and the whole cellular tissue becomes infiltrated with urine.

In such cases the operation of external section becomes an absolute necessity, not only for the purpose of evacuating extravasated blood and infiltrated urine, but for the immediate purpose of getting a catheter into the bladder; for it becomes an almost impossible matter to introduce an instrument *per vias naturales* when the urethra has been lacerated. If, however, a free incision is made through the perineum upon the point of a large sound, first passed carefully down the canal to the point of injury, then the sound can be carried into the bladder and the patient placed in comparative safety.

5th. Traumatic stricture—that is, where a stricture has been formed as the result of a direct injury done to the urethra; for example, where fractures of the pelvis have injured the urethra and blocked up with a dense deposit the perineal and ischio-rectal regions. It is very well known how intractable such strictures prove, and how difficult, in many cases, it is to introduce an instrument of even the smallest size into and through such coarctations. In these cases ordinary dilatation proves inefficient, and internal urethrotomy is often of little or no avail. Here, then, we have an evident and clear indication for external section, as the speediest method by which we can gain access to the bladder.

6th. A calculus impacted in the urethra behind a stricture, if large, may be an indication for opening the urethral canal. In some of these cases it is very difficult and oftentimes impossible to thread even the smallest filiform guide through the stricture for the purpose of conducting the staff of an internal urethrotome. In such cases, when an imperative necessity exists for the evacuation of an over-distended bladder, we have only the

alternative of aspiration or external section remaining; and of the two, external section seems preferable, and should be done, thus removing the calculus and at the same time opening the stricture by an incision directed from behind forward through the coarctation. Even here an exception may arise should the calculus be small, in which event it is best to open the face of the stricture through the axis of the urethra, so as to expose the calculus, which can then be broken up and removed by the urethral brisepierre of Reliquet (Fig. 1), an ingenious instrument for this purpose, which this distinguished surgeon presented to the French Academy for its consideration in 1871.

Fig. 1.

7th. The next indication is when extravasation of urine has occurred from sudden rupture of the urethra, and in a short time extensive sloughing has taken place from infiltration of urine into the loose tissue of perineum, penis, scrotum, and groins. Here is an absolute necessity for making free incisions for the purpose of evacuating necrotic tissue together with pus and urine. In these cases it is well, if possible, to open the urethra at the site of stricture, so as to admit of the introduction of a catheter into the bladder. This is, however, not always possible when we come to consider the disorganized condition of the parts. In such cases nothing is left the surgeon save to meet the emergencies as they may arise.

8th. The last indication, if I may term it such, is the one in which Mr. Reginald Harrison advocates the combined operation of internal and external section. He advocates doing an external section immediately following an internal operation, and then keeping the bladder emptied through a large elastic drainage tube carried from the external opening into the bladder, and retained until the internal urethrotomy has healed. His reasons for this are, that patients, in his hands, have usually suffered

from urethral fever after the first passage of urine, and that they do not have that trouble until the incision has been bathed by the urine in its passage along the canal. To avoid this complication, he advises doing the external section and draining the bladder. As it would necessarily increase the length of this paper for me to enter into a long detail of his special views upon this subject, I shall now close the indications for the operation by calling the attention of those who desire to know more of his paper to *The British Medical Journal*, of July 18, 1885.

In a given case, where an operation has been decided upon, the question arises as to what form of operation offers the best prospects of success, and which, under the circumstances, can be done with most ease to the surgeon. As for myself, I have found the operation as recommended, by Mr. Syme, not only difficult to perform, but unsatisfactory in its results. An established maxim with surgeons has been that "a stricture being permeable to instruments, an external division is contraindicated." Mr. Syme, on the other hand, has reversed this, and made *permeability* an indispensable prerequisite to the performance of an external section. To this I cannot give my unqualified assent, since, in a very large experience, I have found that whenever I have been enabled to pass a guide through the stricture, I have almost always been enabled to perform a successful internal urethrotomy. Mr. Syme has unhesitatingly admitted the danger of his operation, and mentions hemorrhage as being often alarming. This trouble I have not encountered in my *internal* sections, and when I come to examine the records of several hundred cases in which I have done this operation I find only two instances in which hemorrhage has proved a troublesome factor, and both of these made good recoveries. In my operation for internal section I always carry my incisions through the upper portion of the roof of the urethra, as by so doing I am convinced the danger of hemorrhage is reduced to the minimum, because there are no arteries to cut, and the small venous bleeding soon ceases. On the other hand, extensive incisions made into the floor of the urethra and through the integument are done in the line of important structures, and vessels of con-

FIG. 2.

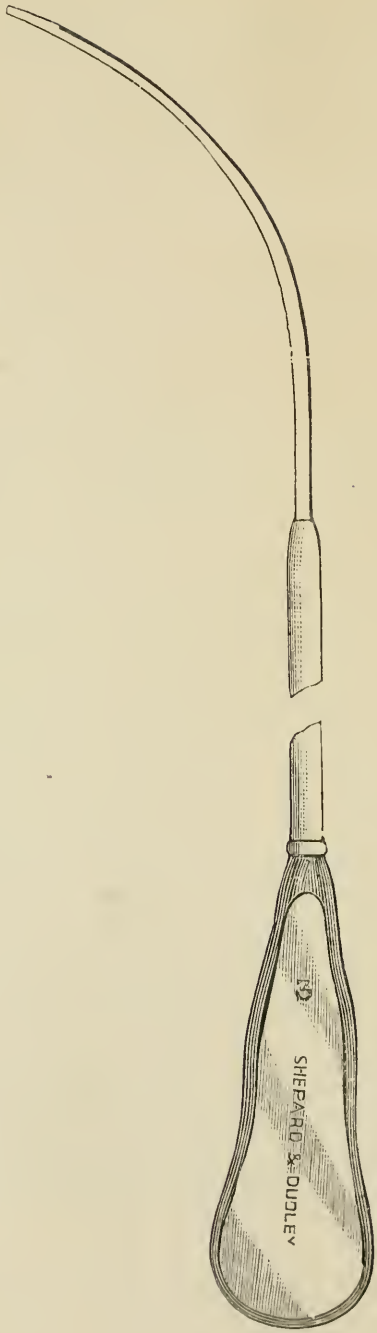
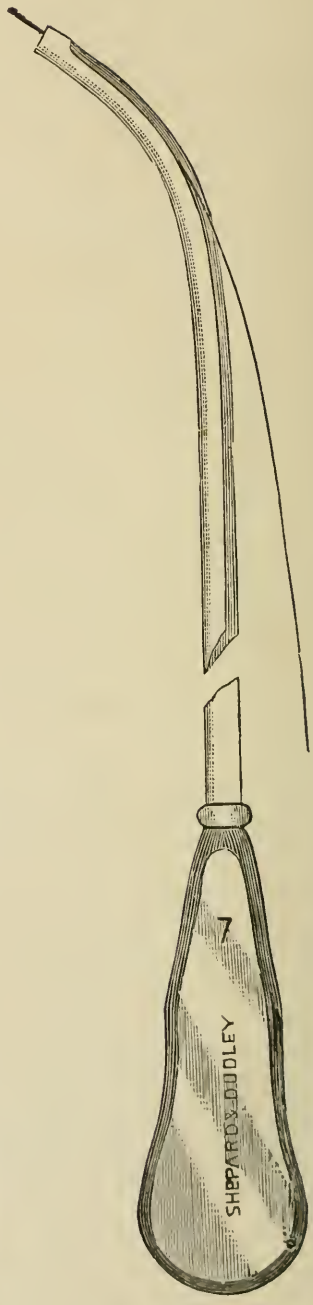


FIG. 3.



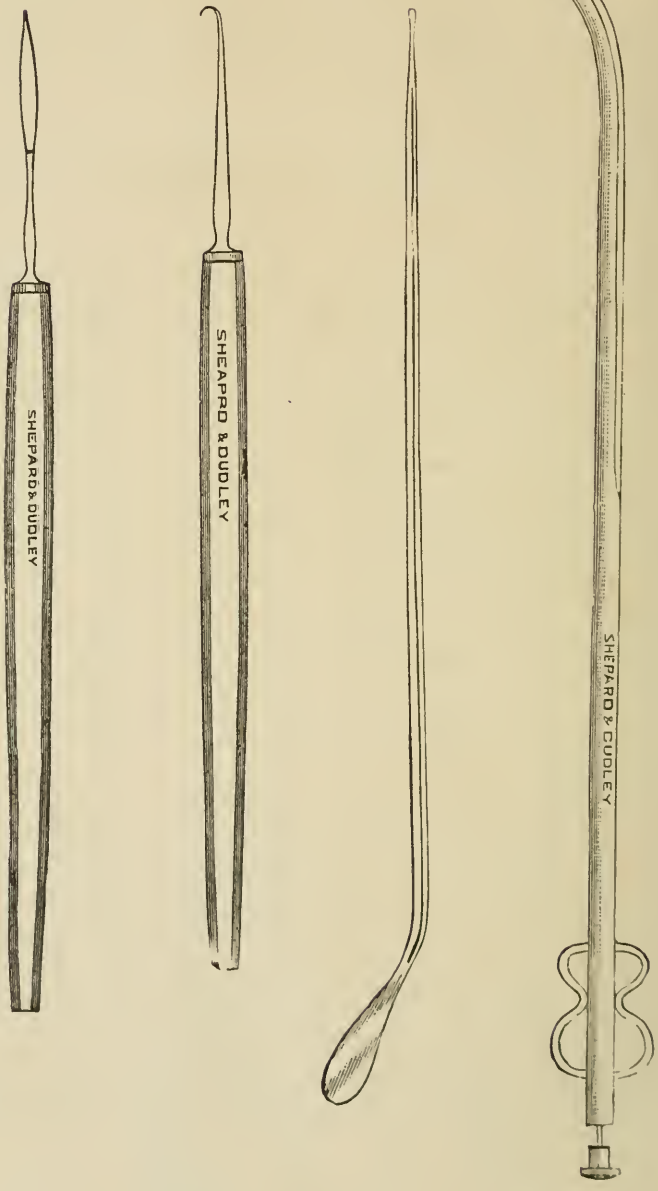
siderable size, which, if wounded, give rise to profuse hemorrhage, and not infrequently serious consequences.

Again, in tight strictures it is extremely difficult to carry the small probe-like director (Fig. 2) from the meatus down the urethra and through the stricture; especially is it difficult to do so if there be false passages in the urethra, or within the stricture itself, and even if there be none already formed it is a very easy matter to make them. Hence it is that I should prefer to select the modification of this operation as proposed and introduced to the profession by my friend Dr. Gouley, of New York.

The main points in his operation consist in the manipulation of a delicate whalebone guide through the stricture, upon which guide he threads his tunnelled sound (Fig. 3) and passes it down to the anterior face of the coarctation; after which he opens the urethra from the outside upon the groove of the sound just in front of the stricture. This being accomplished, he searches for the whalebone guide, which then serves to conduct a very delicate, narrow-bladed knife (Fig. 4) into and through the obstruction; then the whalebone guide is removed and its place supplied by a delicate probe director (Fig. 6), which is pushed on into the bladder, and then the urethra, superficial fascia, and integuments are freely opened. His first incision is made directly in the median line of the perineum from the base of the scrotum to within half an inch of the margin of the anus, and is usually one to one and a half inches in length.

In opening the stricture he directs that the edge of the knife be held downward, and that the coarctation shall be freely divided, taking care to carry the incision into the uncontracted canal about half an inch posteriorly. The case is then left to nature, and the urethra and the wound to the unobstructed passage of urine. The objections to Dr. Gouley's method are, the large size of the external incision, and the length of time required for the wound to granulate and heal. His incision through the stricture being made in the floor of the urethra endangers bloodvessels of importance, which become difficult

FIG. 4. FIG. 5. FIG. 6. FIG. 7.



of ligation if cut. The wound left to granulate is liable to the formation of numerous fistules, and a long time elapses before the patient is well enough to resume his ordinary vocations.

In this connection, I may refer to the method of Mr. Wheelhouse, which is known as "the Leed's operation." It possesses some advantages over the other forms which have been mentioned, chiefly so, from the ease with which it is performed; but it has still the disadvantage of leaving an open wound in the perineum to heal by granulation, and consequently it is liable to the after-consequences of perineal fistula. Mr. Wheelhouse certainly deserves great credit for the very ingenious and practical manner in which he has planned his operation, and his procedure has the advantage of greatly increased precision over any other form with which I am acquainted. By it an operation which was hitherto one of the most difficult in surgery, has been rendered comparatively easy, and the published reports go to show that the results have been vastly more favorable than from any other method yet described.

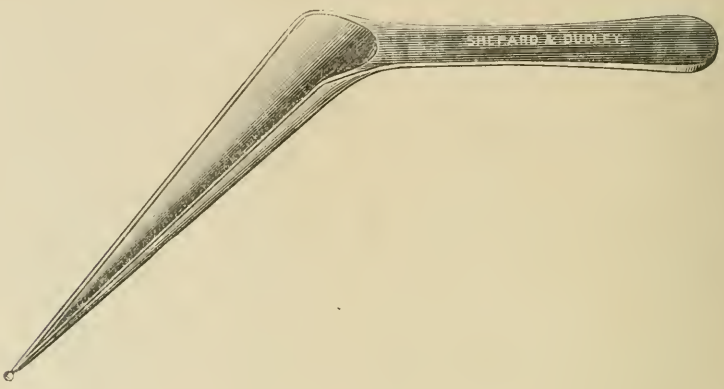
This operation is done upon a special staff designed for the purpose, which instrument is fully grooved through the greater part, but not through the whole of its extent, the last half inch of the groove being stopped and terminating in a rounded button-like end (Fig. 8). The urethra is opened *in the groove of the staff, not upon the point;* in this way, certainly securing at least

FIG. 8.

a quarter of an inch of healthy tube in advance of the stricture; the opening in the urethra being held apart by two pairs of fixation forceps, applied one on either side, and the upper angle held up by the button extremity of the staff hooked in it. This opens the urethra and fully exposes the face of the stricture, in which the opening is searched for with a probe-pointed director, which, when it enters the bladder, is turned down so that the groove faces toward the perineum. Then the knife is directed

along the groove and the stricture is carefully and deliberately opened on its under surface, and the passage thus cleared. This being accomplished, the probe-gorget of Mr. Teale (Fig. 9) is passed into the bladder with its concavity looking toward the

Fig. 9.



pubis, so as to receive the point of a catheter, which is now introduced along the urethra until it reaches the gorget, by which it is conducted into the bladder; the gorget is now removed and the catheter tied in to remain three or four days. After the expiration of that length of time the catheter is removed, only to be reintroduced each day or every second day, so as to keep the urethra in a state of patency until the wound in the perineum has thoroughly healed. The operation is ingenious, and, as a form of "la boutonnière," it deserves to be recommended; still it has, to my mind, the disadvantage which attends all of these operations, viz., leaving an extensive wound in the perineum to heal by granulation, exposing the patient to the dangers of pyæmia, and the liability of urinary fistulæ as a sequence. A very interesting description of this operation is to be found in the *British Medical Journal* for June 24, 1876, from the pen of Mr. Wheelhouse himself.

The idea has prevailed that, when the external incision is not large and free, urinary infiltration will necessarily take place; but this is an erroneous conception like that which has existed

in reference to cutting for stone. The urine, obeying the natural law of gravity, does not infiltrate and burrow under tissues when it has an open channel through which it can escape. So it is, whenever a stricture has been fully divided, the urine necessarily follows the course of the urethra.

The healing and suppuration of an open wound being long and tedious, and consequently exposing a patient to the risks of pyæmia, whilst structures having no connection with the existence of the stricture are unnecessarily divided, naturally induced the profession to seek other and less formidable measures of relief. These facts led Mr. Henry Dick, of London, in the year 1853, to publish, in the *Medical Times and Gazette*, a critique upon the operation of Mr. Syme, and at the same time to lay before the profession a description of a new operation, which he termed "The Subcutaneous Division of Stricture." Subsequently he presented, in 1855, a memoir to the Academy of Medicine of France upon the same subject, and therein gave the histories of several successful operations which he had performed. After this, the operation was adopted by Mr. William Allingham, and also by Mr. William Adams, both of whom made favorable reports of successful operations.

I will now briefly describe the method of Mr. Dick, and then close this paper with an illustration of an operation which I devised in 1868, and which, to the present time, I have seen no valid cause to discard.

His method consists in first dilating the stricture sufficiently to admit the director of his catheter, which is a medium-sized catheter of moderate curve, upon the end of which are two buttons or knobs having a groove between them, which groove is continued on, into, and along the director; the catheter contains the small grooved director which can be drawn in or pushed out, so as to traverse the stricture (Fig. 10).

The operation is done in the following manner: The catheter, with the director concealed within it, is passed down the urethra until its point reaches the anterior face of the stricture, when, by a gentle manipulation, the point of the director is made to engage the stricture, and is then passed on until it enters the

bladder; the surgeon then takes a very small sharp-pointed tenotome (Fig. 11), and, feeling in the perineum with the index finger of his left hand for the buttons or knobs, plunges the

FIG. 10.

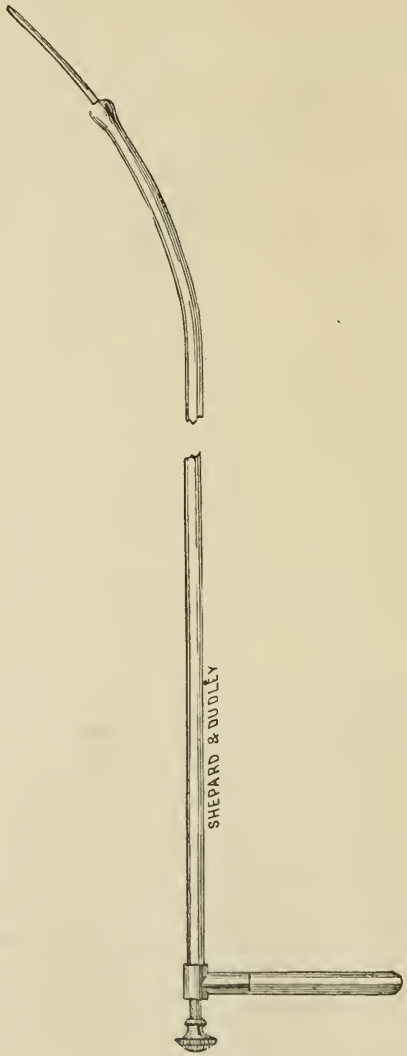


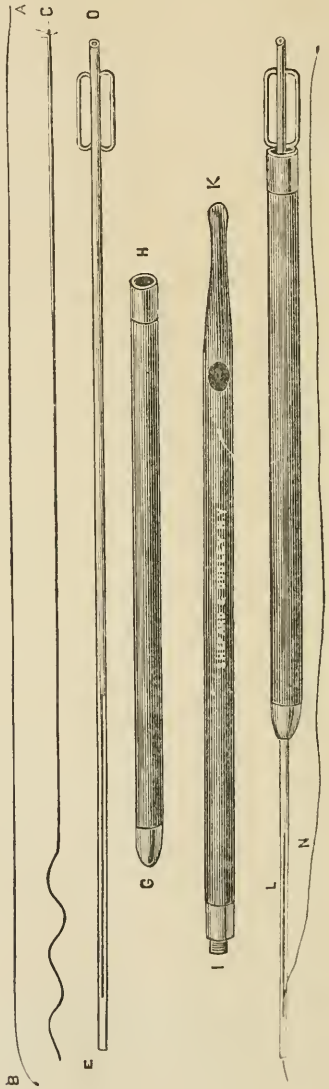
FIG. 11.

knife between them into the groove and along the director through the stricture, being at the same time careful to see, or rather to feel, that the stricture is freely cut throughout its entire length, the edge of the tenotome being directed downward. After the stricture has been freely incised, the director is withdrawn into the catheter, which is now removed from the urethra, and a full-sized catheter passed into the bladder to ascertain whether the urethra has been fully cleared, and also to empty the bladder of any urine which may be present. The little wound is covered by a bit of adhesive plaster, a compress with a T-bandage completes the dressing. No retained catheter is left in the urethra, but whenever there are calls to urinate, the water is drawn off with either a silver or soft catheter. This is certainly a very unique and ingenious operation, and one which strikes at the chief point of objection to all external operations done in the old way, viz., an open wound in the perineum which, in most cases, must heal by the slow process of granulation. Still there are objections to Mr. Dick's operation which will necessarily prevent its coming into general use. In the first place, it is difficult to perform, and requires a degree of dexterity which does not belong to the profession at large; then we have no absolute proof that the director has traversed the stricture, for it may have penetrated a false route, and the incision made subcutaneously, in that event, might be productive of serious consequences. Then, again, he holds as a necessity that *the stricture must, to a small extent, first be dilated;* this is required before his conductor can be introduced. Now, if it is possible to dilate the stricture sufficiently large to admit his director, I hold, upon the same grounds of objection to the operation of Mr. Syme, that there is no necessity for an external operation for the reason that, if a director can be passed, it is possible to dilate, or, this failing, then to do the safer operation of internal urethrotomy.

Mr. W. F. Teevan, of London, has proposed and executed a modification of the operation of Mr. Dick, having the same end in view, viz., to do away with a large external incision, and substitute in its place a small opening through which he prac-

tised a subcutaneous urethrotomy. The method employed was simply one in which a small whalebone guide was worked

FIG. 12.



through the stricture, and over this a small conducting catheter was in its turn introduced into the bladder; then along its groove the tenotome of Mr. Dick carried through the contraction, and the after-treatment conducted as in the operation of Mr. Dick. I am not informed of the success which has attended this procedure of Mr. Teevan; but if permitted to judge of the operation by the instruments which he used (Fig. 12), I am not very favorably impressed with it.

I now desire to describe briefly an operation which I have employed since the year 1868, whenever an occasion has demanded an external section. Thus far it has proved entirely satisfactory to me, and especially so to those upon whom I have had an occasion to perform it.

In the year 1872 I wrote a paper upon the result of my operations by this method, and since that date to the present, with an increased experience, I have seen no reasons to alter the views which were then expressed. I now claim nothing of originality for the operation, since it is based almost entirely upon the old *la boutonnière;* the incision being very small, and made anterior to the stricture; then, a very small probe-pointed director, or whalebone guide is passed along through the stricture, and a delicate tenotome incises its upper wall subcutaneously; the small wound in the integuments is closed by pin sutures, and left to heal by primary union. Adhering to the maxim, "dilate where you can, cut where you cannot," I only resort to this operation in those cases where no catheter or guide can be made to traverse the urethra from the meatus to the bladder; cases which require some operation for the immediate evacuation of retained urine, and in which it is not possible for me perform an internal urethrotomy.

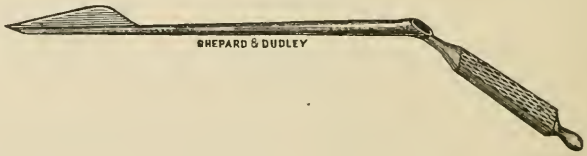
The patient, duly prepared by opening the bowels freely with an enema, and a hot hip bath given to tranquillize the nervous system, is placed upon a table, then secured in the ordinary position for cystotomy, and anæsthetized. I now pass down the urethra the tube of Benique (Fig. 13), which is a plain silver tube open at both ends, about nine millimetres in diameter, and from six to eight inches in length; this tube protects the walls

of the urethra, and puts on the stretch the face of the stricture. The tube is now filled with a bundle of small filiform whalebone probes which are carefully passed down to the stricture; by trying first one and then another it is possible that one may

FIG. 13.

engage the opening and pass on into the stricture. This being accomplished, I remove the disengaged probes together with the tube, and after securing the probe in the bladder, I pass over it a Wheelhouse staff which has been drilled through its end to answer the purpose of a Gouley staff, and carry it down to the stricture; it is now handed to the assistant, who holds it lightly, yet firmly, against the coarctation, whilst I open the urethra in the groove of the staff, making an incision about half an inch in length. I then draw outward the staff just sufficiently to enable me to find the whalebone probe as it passes through its end and on into the stricture; this I secure by passing a small blunt hook behind it, after which the staff is removed entirely from the urethra, and the distal end of the probe drawn out through the little wound which has been made; and now, over the probe I pass a little gorgeret (Fig. 14); this

FIG 14.



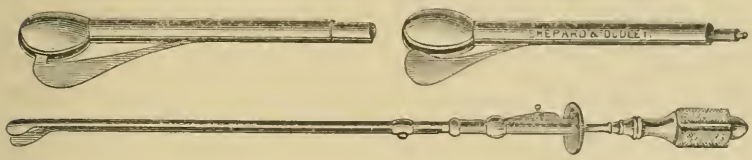
has its blade directed upward, and being run along the probe, as its guide, it passes through the opening into the urethra, and then down the stricture, which is cut on its superior face. A catheter is now passed along the entire urethra into the bladder and the urine evacuated, after which I carefully examine the

site of the stricture with graduated metallic ball probes (Fig. 15) for the purpose of detecting any bands which, perchance, may

FIG. 15.

remain; if found, they are divided by the retrograde urethrotome of Civiale (Fig. 16), and the full calibre of the urethra restored.

FIG. 16.



In the event, however, that it is not found possible to pass a whalebone probe in the first instance, so as to gain command of the stricture before opening the urethra, I then pass either the staff of Wheelhouse, Gouley, or an ordinary staff of slight curve with deep groove, down to the face of the stricture and practise the Leed's operation, with the exception that I do not rip open the whole stricture; but having gotten the whalebone probe through the coarctation, I thread over it the little gorgeret and incise it on its superior face, just as described in the instance where the probe was passed along the tube of Benique, always taking care to sever any and all bands which may remain. This opening simply serves the purpose of shortening the canal and bringing us nearer the obstruction; it furnishes us a passage of only some few lines in length in which to manipulate our instruments, in place of a canal of several inches in extent, as would be the case if the urethra had not been opened. I thus, virtually perform an internal section; I do not rip open the whole coarctated canal and lay bare to the external wound the cavity of the urethra, but I leave it, so far as the stricture is in question, just in the same condition as an urethra upon which I had done an internal urethrotomy.

In the absence of the little gorgeret, I have found a very nar-

row-bladed urethrotome of Maissonneuve, conducted by a small filiform bougie passed through the external opening and coiled within the bladder, to serve a most excellent purpose, provided the staff is grooved on its concavity, so as to insure the incision being made upon the roof of the urethra. Such, in brief, is the method I have adopted of operating *externally*, and find that it is easy of execution, and satisfactory in its results.

Having carefully divided any existing bands, and restored the lumen of the urethra, I then pass a sound into the urethra, and, after the slight oozing of blood has ceased, I wash the parts thoroughly with cold water, to which may be added either a chlorine or weak mercury solution for the purpose of cleansing and disinfecting the wound; now I close the wound accurately with two or three pin sutures, passed deep enough to engage the divided edges of the urethral canal, and, after coaptating the edges of the skin, I encircle the pins with a flat thread in the form of the figure 8; then the sound is removed, and its place occupied by a full-sized catheter passed down to the prostatic urethra, but not into the bladder. The patient is put in bed and kept on his side, with instructions to push the catheter into the bladder when he has a call to urinate, and always, so soon as the urine has been discharged, to withdraw the catheter sufficiently far to get it out of the bladder, but not beyond the stricture. This catheter is used for only twenty-four to thirty-six hours, just long enough to insure the protection of the wound from the passage of the urine until it has been in a measure glazed over, and the strictured portion softened up by the presence of the inlying catheter. On general principles I am opposed to the *sonde à demeure* or retained catheter, and for obvious reasons too patent to need mentioning here; but the sound or catheter, used as I suggest, answers all the purposes for which it is intended, and keeps the urine from the wound until it is sufficiently protected by a glaze which prevents the urine passing into the external incision. At the expiration of this time the catheter is dispensed with and the patient left to pass his urine at will. About the fourth, or, at latest, the sixth day, I remove the pins, and do nothing more to the wound save keep

up the dressing of lead-water and opium—which is applied immediately after the operation—for two or three days longer. Now the patient is permitted to get up and stir about, and within eight or ten days he resumes his former vocations. The after-attention is such as is usual in all operations for stricture, whether they be external or internal, viz., the systematic use of gradually increasing steel sounds until the maximum calibre attainable in the special urethra has been reached.

With this course judiciously pursued, I find that I am able to discharge my patients perfectly healed within from eight to twelve days; and in not a single instance, out of some twenty-five to thirty operations, have I had to contend with any hemorrhage or the annoying complication of urinary fistulæ.

The advantages to be derived from this operation are, the short time of confinement for the patient, freedom from hemorrhage, quick union by primary adhesion, and the small amount of resultant cicatricial tissue, which is always deposited in greater proportion the longer the healing process continues. The retained catheter for the first day or two does good rather than harm, since it protects the fresh incision from the toxic effects of the urine until it has become glazed over with lymph, and acts, at the onset, by pressure upon the divided stricture, compressing the vessels which have been divided and which might bleed after reaction; it also sustains the urethra as a splint, and prevents the stricture from reuniting until we have time to begin gradual and systematic dilatation with the steel sound. The comparative immunity from urethral fever which my patients have enjoyed after this operation, I feel certain, is due almost entirely to the use of the inlying catheter as I employ it. I do not desire to be understood that I advocate the use of a retained catheter throughout the entire confinement of the patient to bed, but that I use it for only the first twenty-four to thirty-six hours—just sufficiently long to permit the wound to glaze over with lymph, and model, as it were, the granulations by gentle pressure.

In examining the details of the last ten operations which I have done by this method—all of them bad cases—I find that they were enabled to get out and be around the city in the fol-

lowing order: 3 on the fourth day after the operation, 1 on the fifth day, 2 on the sixth, 2 on the seventh, 1 on the ninth, and 1 on the twelfth. The others recovered in about the same proportions.

I am not apprised if any other method of performing external urethrotomy has afforded like rapid results.

Summary.

1. Antiquity of operation.
2. Brief history of its progress.
3. Methods of performing it.
4. Objections to performing it, when possible to pass a conductor into and through the stricture.
5. Objections to leaving an open wound in the perineum to heal by granulation.
6. The advantages of subcutaneous urethrotomy, when unable to relieve the patient by either dilatation or internal urethrotomy.

DISCUSSION.

Dr. N. P. Dandridge, of Cincinnati, Ohio.

I have listened with great interest to the paper and feel much embarrassed in attempting to discuss it. On my part, the discussion must be based on theoretical considerations. I presume that Dr. Mastin is the only one present who has performed this operation, or any operation approximating it in character. It has stood the crucial test. It has been successful, and the report of his last ten cases certainly shows that, in his hands, it has some important advantages over ordinary external urethrotomy. As I understand the purport of the paper, it is in contrast to external urethrotomy that this new operation is to be discussed. Following the course of the paper, I heartily concur with most of the conclusions which have been reached. Possibly, I do not entirely agree with the proposition that where fistula exists internal urethrotomy will yield satisfactory results. In the majority of cases, unless the stricture is very recent, and its walls have not become the seat of induration, I think that external offers much greater safety to

the patient than internal urethrotomy. I should say that instead of internal urethrotomy being the rule it should be the exception, not denying that in some cases it may be proper. In regard to the other indications for external urethrotomy, I believe that I am almost entirely in accord with the teachings laid down by the essayist.

I cannot help thinking that too much stress has been laid upon the danger of incision along the floor of the urethra. In certain cases I think that there is an advantage in making the incision in this position, for it happens, probably in the majority of cases, that the thickest portion of cicatricial tissue is developed along the floor of the urethra, and in all cases I think that it is very desirable that the incision should go entirely through the strictured tissue.

The ingenious method adopted for opening a very difficult stricture by the introduction of a tube and filling it with filiform bougies is, I think, of decided advantage. I have used a similar method in certain cases. I think that the metallic tube is to be preferred, although I have used only a soft catheter open at the lower end. This tube aids materially in passing the filiform bougie through the stricture. The passage of the bougie seems to me to be of material assistance in the subsequent steps of the operation. In fact, without this filiform guide passed through the stricture I do not fully follow the author in all the steps of the operation. Through the small incision which is made, it seems to me that it would be difficult to find the opening in the stricture with either a probe or filiform bougie passed through the perineal opening. If a filiform has been already passed through the urethra, I can understand how it might be drawn out of the wound and act as a guide for the cutting instrument.

A disadvantage, and a considerable one, is that the operation requires special instruments, and special instruments for their successful employment must have special skill. The successful results which have been reported are, no doubt, largely owing to the dexterity of the author of the operation. It seems not at all impossible that, the filiform having been passed through the stricture, as the knife was driven on, the guide might curve upon itself and so no longer act as a safe conductor for the ingoing knife. The liability to such an accident would, of course, depend largely upon the dexterity of the operator; but I cannot help thinking that it might occur in the hands of even those who had considerable experience, where they had to deal with a resisting stricture.

After the operation, the inlying catheter is a disadvantage. One of

the great advantages of external urethrotomy is the free drainage which it affords. In many of these cases this drainage is exceedingly desirable not only in cases of traumatic rupture and infiltration, but also in some cases where cystitis has developed. In such cases the advantages gained by the drainage, counterbalance the disadvantages arising from keeping the patient in bed for a considerable length of time.

As doubtless there are others who desire to participate in the debate upon this interesting subject, I shall not detain the Association any longer. I desire to express the gratification which I have derived from the paper which Dr. Mastin has presented.

Dr. David Prince, of Jacksonville, Illinois.

I feel great diffidence in speaking upon the subject of stricture of the urethra because it is not in the circumstances of my practice to have a great number of cases. I have, however, had some cases as bad as can be, and having managed them satisfactorily, I feel competent to explain the method of treatment. It will appear from what I am about to say that a case of traumatic or of inflammatory stricture which can be entered at all by any kind of probe or bougie, need not be cut, and that in many cases in which nothing will pass, a passage may be secured by a change in the texture or consistence of the tissue. I offer no criticism upon the paper just read, upon a peculiar manner of incision, nor upon any other manner of incision or dilatation, but I wish to offer a few remarks upon the treatment of stricture of the urethra by the employment of a continuous galvanic current. Not a faradic or interrupted current, which has high tension with very little chemical force, but the primary galvanic current sufficiently intensified by passing from one cell through the next and the next, until a sufficient tension has been acquired to overcome the resisting force of the tissues, and thus to pass through them in sufficient quantity of current to exert a chemical action, changing the composition of the *tissues*, without destroying them.

It can be seen by an experiment upon a potato, or any similar substance, that the introduction of a needle carrying the negative or hydrogen-producing current develops hydrogen not only at the front and sides of the needle, but in the cellular substance for a considerable distance around. At the same time oxygen accumulates at the point and sides of the needle carrying the positive current; and if some potassic iodide be placed upon the surface of the potato, the liberation of the iodine will be seen to extend a considerable distance from the

needle. The oxygen and the iodine tend to unite with the iron of the needle, while the potassium and hydrogen are drawn toward the negative needle. The oxygen and the iodine destroy the tissues by burning them, while the action of the alkalies and the hydrogen has a disintegrating tendency without destruction, unless the process is carried to an extreme degree. This is an explanation of a fact well established, that living animal tissues are capable of being softened by the disintegrating influence of hydrogen so as to offer a diminished resistance to distending forces.

In a stricture of the urethra, whether resulting from a mechanical injury or from an inflammation induced by a contagious cause, there comes to be a neoplasm of a dense character, of low vitality, which, like cicatricial material elsewhere, has a tendency to contract and to lessen the size of the tube which it surrounds.

The introduction of a steel bougie as a carrier of the negative current, affords the condition necessary to the introduction of this current into the surrounding cicatricial tissues.

Theoretically, the positive pole should be on the surface of the body, so placed that the large wet sponge employed will be nearer to the point of the bougie than to any other part of it. This leads to an accumulation of hydrogen about the point of the instrument, though it will gather in diminishing intensity for a considerable way back upon the bougie. The diffusion of the current upon the sponge diminishes the sensible effects upon the nerves of the skin, and enables a stronger current to pass than would otherwise be borne.

The centre of influence and the place of greatest decomposing effect is carried to the metallic conductor by the increased resistance in passing through the cicatricial tissue, which has in it less saline fluid than has the normal tissue in the parts in the direction of the sponge. The centre of influence is thus close upon the bougie, softening the tissue, diminishing the resistance, and making the stenosis yield readily to the pressure of the steel.

The success of the practice is supported by observation, and the explanation is drawn from the known behavior of the galvanic current under observation for experimental purposes. The galvanic current has another effect, and that is to allay spasmodic action by benumbing nervous sensibility and weakening muscular action. The element of *shock* is thus greatly reduced, adding both to the comfort and the safety of the patient.

In many cases of moderate stricture, the antispasmodic element is of

very great importance in the management of the case. To allay this is to remove one of the difficulties in the treatment by other methods.

Mr. H., a gentleman about forty years old, came to me in October, 1882, with a stricture impassable by ordinary means. He was spending several hours each day in passing his urine drop by drop. He was discouraged by the failure of previous treatment by several good surgeons. Over two hours was spent in getting the point of a Holt's dilator through under a current which produced a burning sensation under the sponge upon the sacrum. Afterward the follower was passed down upon the track of the instrument. The instrument was passed in a shorter period of time the next week. The treatment was repeated once a week, the time required to enter the bladder being each time less, until the largest follower in Holt's apparatus was passed. Then the dilator was discontinued, and the ordinary steel bougie under the galvanic current was passed at each sitting. His occasional attendance extended through a period of about six months, since which time he has continued well, not having any impediment or discomfort in urinating.

What gives this method a superiority over the cures effected by cutting and stretching, is the permanency of results. The cicatricial material is not only softened for the time being, but, if the influence of the galvanic current is continued for a considerable period, it is absorbed and is not reproduced.

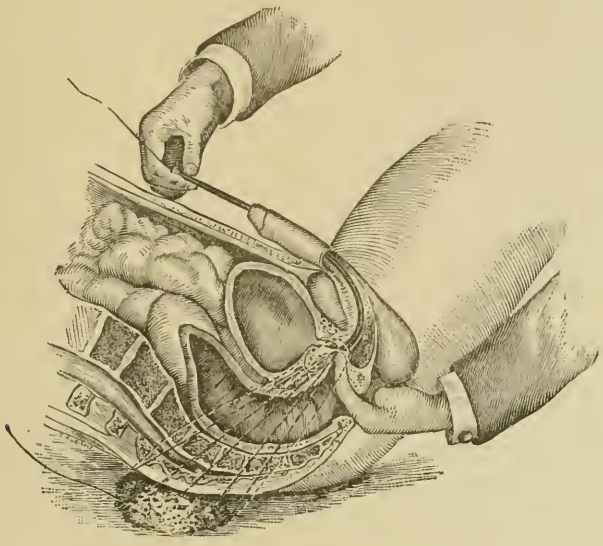
In Beard's *Archives of Electricity* for May, 1874, and in the *New York Medical Record* for August 12th and August 19, 1882, are reports of the electrolytic treatment of stricture by Dr. Robert Newman, of New York, in which are related cases of great success in the worst conditions and of performance of result. Dr. Newman employs a bulb, the metallic stem of which is insulated, and the sponge which constitutes the positive pole is in the hand or on any convenient part of the body. The patient is treated standing. This is believed not to be the best position. I have treated my patients in a reclining posture, the sponges for attracting the oxygen being in contact with the surface over the sacrum, so that the point of the bougie is nearer to the sponge than is any other part of the bougie.

The application of the bougie carrying the negative current is of great value in spasmodic strictures attendant upon irritable conditions of the mucous membrane, and for reducing those congestions which keep up seminal discharge.

The battery which I employ is the Leclanché, the same which is

now generally used for telephone purposes. Fifty cells in good condition are sufficient, but it is better to have one hundred cells, so that a sufficient quantity of current may be made to pass when the apparatus is not in first-rate order.

The accompanying figure illustrates the theory and the practice explained in these remarks.



The introduction of a finger into the rectum in difficult cases is of great use in determining the position of the point of the instrument.

Dr. T. J. Dunott, of Harrisburg, Pennsylvania.

I have been much interested in the paper of Dr. Mastin, and have no doubt that the best operation for certain types of stricture is the one he proposes. My opportunities have not equalled those of surgeons who have in their care the great hospitals of large cities, yet my experience in dealing with impassable stricture, and its surgical sequelæ of fistula in perineo and abscesses, has been considerable.

Almost without exception they have been operated on by internal urethrotomy done on a whalebone guide followed by dilating sounds. At present I have a case where the periurethral and scrotal induration exceeded anything I have previously met with; there were several

points of stricture and many fistulous openings on the scrotum and in the perineum. Yet the bladder was readily reached when the filiform guide had passed the strictures.

The main difficulty which presents itself to me when listening to statements connected with operations for stricture, is to determine why so many surgeons prefer external to internal section. In fifty or sixty cases of so-called impermeable stricture, occurring in my practice within the last twelve years, very rarely indeed has external section been required, and yet the records show that it is a very frequent method of treatment practised.

I incline to believe that the great obstacle in the way of success by the use of internal methods is want of patience on the part of the operator, and am convinced that almost without exception even in tortuous strictures, where only drops of urine can be expelled through the natural channel a filiform guide will pass in and then all subsequent steps in the operation become comparatively easy of execution, and are completed with a minimum of risk to the life of the patient.

Dr. MASTIN. I have nothing to add to the paper more than what has been written. I cannot comprehend that Dr. Dandridge has offered any positive objections to the points which I have made; and as to the special skill and dexterity to which he attributes the success of the operation in my hands, I can only reply, the operation is not difficult to perform, but with proper instruments no valid reason exists why one surgeon as well as another may not have similar results. In reply to Dr. Prince, I may add that the treatment of urethral strictures by electrolysis has not proved an established success. It was first employed by Crussel, subsequently by Willebrand and Wertheimer; then carefully studied by Jaksch and Leroy d'Etiolles without positive results. Then the subject was taken up by Mallez and Tripier in 1867, who published extraordinary success, which success was not sustained in the experiments made by Drs. Keyes and Beard at the Charity Hospital of New York, nor by Dr. Rockwell in his private practice, although substantially the same method was employed which had been adopted by Mallez and Tripier. The operation proved to be painful, and was far from satisfactory to either patient or surgeon. Recently Dr. Robert Newman reported quite a number of cures of stricture by this method, but since he considers a stricture cured which will only admit of the passage of a No. 12 English catheter, we cannot accept his dictum as authority. I am, however, free to admit that the

use of a faradic current will often allay that irritation of the urethral wall known as *spasmodic stricture*, so as to enable us easily to introduce a sound; but this is a very different matter from softening up an organic contraction within the urethra by the use of electrolysis.

In answer to Dr. Dunott, I have only to add, "multiple strictures with excessive induration," are amenable to the same treatment that single strictures require; and as for haste in any operation upon the urethra, I am clearly opposed, that point being especially insisted upon in the body of the paper.

AN IMPROVED TRACHEOTOMY TUBE.

EXHIBITED BY

ROSWELL PARK, A.M., M.D.,

OF BUFFALO.

In one of the late numbers of the *Dublin Medical Journal* is contained the figure of a tracheotomy tube devised by Dr. Nairn, of Ireland, the tube having anterior and posterior blades. On that principle, I have devised something which I think is better.

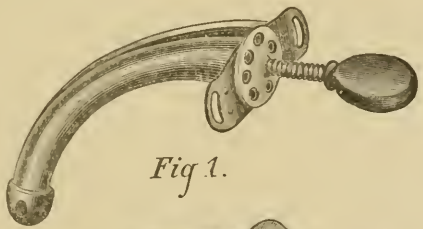


Fig 1.

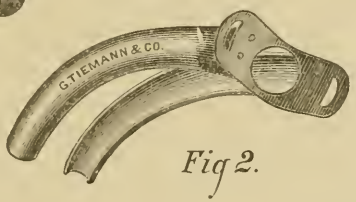


Fig 2.

This tube is made of aluminium and has lateral blades. These are joined in front by a little spring, so that it has a tendency to be self-retaining. To facilitate introduction of the tube, there is a little obturator with a small hole through it. When the tube is in place, the obturator may be removed. The value of this instrument is that it can be readily cleansed.

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